THE EFFECTS OF PROGRAM CONTROL, LEARNER CONTROL AND LEARNER CONTROL WITH ADVISEMENT LESSON CONTROL STRATEGIES ON ANXIETY AND LEARNING FROM COMPUTER-ASSISTED INSTRUCTION

BY

RANDALL PHILLIP COOROUGH

A DISSERTATION PRESENTED TO THE GRADUATE
SCHOOL OF THE UNIVERSITY OF FLORIDA IN
PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

UNIVERSITY OF FLORIDA

1990

This dissertation is dedicated to my parents and grandparents,

and especially to

Ann

ACKNOWLEDGEMENTS

This dissertation is the culmination of many years of intensive study and dedicated work and whose completion would not be possible without the encouragement, inspiration and advice of many people. I would like to give thanks to Dr. William Chen for his help with this study and in addition for his encouragement and support that influenced me to attend the University of Florida. I would like to thank Dr. David Miller for his invaluable advice and assistance in helping with the design and data analysis portion of the study. I would like to give special thanks to Dr. Lee Mullally and Dr. Jeffry Hurt for their countless hours of advice and support that made this research effort possible. Dr. Mullally's educational philosophies and enthusiasm for teaching were instrumental in my decision to pursue an advanced degree in instruction and curriculum at the University of Florida. Dr. Mullally and Dr. Hurt have provided untold amounts of encouragement, inspiration, and friendship that have made my academic experience at the University of Florida truly rewarding. I would also like to thank Dr. Beth Downs for her support and encouragement and for showing me that my goal was attainable.

Special gratitude is extended to the staff of the Faculty Support Center for Computing for their encouragement, assistance and for providing me with the facilities to complete this research project.

I would like to thank Dr. Morgan Pigg, Chairman of the Department of Health Science Education, for giving me special permission to utilize the students in the Personal and Family Health classes. Special appreciation is extended to Olivia Gostanian for her cooperation and assistance in planning and carrying out this research project. Olivia was invaluable in helping to motivate her students to volunteer their time for participation in the study. I would also like to thank the students from the Personal and Family Health classes who volunteered their precious time to complete the computer-assisted instruction program.

The completion of this dissertation would not have been possible without the love and support of some very special people. I would like to thank my brothers and sister, Tim, Nicholas and Kristi, for their love and kind words of encouragement when I needed it. I extend sincere thanks to my parents and grandparents for their love, patience, and the faith they have shown in me. Finally, I extend my deepest appreciation to Ann for her love. She has been my unending source of inspiration and motivation throughout this study.

TABLE OF CONTENTS

page
ACKNOWLEDGEMENTS iii

LIST OF TABLES viii

ABSTRACT ix

CHAPTERS

1 INTRODUCTION 1

Statement of the Problem 5
Justification for Study 7
Hypotheses 8
Assumptions 10
Limitations 10
Delimitations 11
Definition of Terms 11
Organization of Remaining Chapters 13

2 REVIEW OF THE RELATED LITERATURE 14

Computer-Assisted Instruction 16
  CAI Instructional Uses 17
  Advantages and Disadvantages of CAI 19
  CAI Effectiveness 21
CAI Instructional Designs 21
  Locus of Instructional Control Strategies 23
  Learner Controlled Instruction Research 24
    Learner control of lesson pacing 25
    Learner control of lesson sequence 27
    Learner control of other instructional variables 30
    Adaptive control studies 32
    Learner control with advisement 35
Anxiety 38
  Theories of Anxiety 39
  State-Trait Anxiety Theory 43
  Anxiety in Instruction 45
Anxiety and CAI 48
  The Effects of State Anxiety on Performance in CAI 49

Anxiety and Learner Controlled CAI.....52
Summary.....54

3 METHODOLOGY.....58

Subject Selection.....58
Instrumentation.....59
State Anxiety Scale.....59
Pretest - Posttest Measurements.....62
Instructional Content of the CAI Lesson.....62
Computer-Assisted Instructional Treatments.....63
Program Controlled CAI.....63
Learner Controlled CAI.....63
Learner Control with Advisement CAI.....64
Courseware Design and Development.....65
Pilot Study.....66
Procedure.....67
State Anxiety Scale Assessments.....67
Pretest Procedures.....68
Posttest Procedures.....68
Experimental Design.....68
Data Analysis.....69
Summary.....70

4 RESULTS AND DATA ANALYSIS.....71

Study Subjects.....71
Results.....72
Summary.....79

5 CONCLUSIONS AND RECOMMENDATIONS.....80

Findings.....81
Discussion.....82
CAI and State Anxiety.....82
Pretest.....86
State Anxiety Levels During CAI.....86
CAI Locus of Instructional Control Strategies.....87
Gender.....89
Achievement and CAI Locus of Instructional Control.....90
State Anxiety and CAI Locus of Instructional Control.....91
Time.....91
Implications.....93
Recommendations.....96
Summary.....97

APPENDICES

A SAMPLE INSTRUCTIONAL FRAMES 99

B SAMPLE QUESTIONS FRAMES 100

C SYSTEM-LEVEL FLOWCHART FOR PROGRAM CONTROL 101

SYSTEM-LEVEL FLOWCHART FOR LEARNER CONTROL 102

SYSTEM-LEVEL FLOWCHART FOR LEARNER CONTROL WITH ADVISEMENT 103

REFERENCES 104

BIOGRAPHICAL SKETCH 116

LIST OF TABLES

Table page

3-1 Means and Standard Deviations for Pretest and Posttest Scores by Treatment Condition 72

3-2 Means and Standard Deviations for State Anxiety Measurement Occasions by Treatment Condition 73

3-3 Source Table of ANOVA of State Anxiety Change Across Measurement Occasions for Treatment Conditions 74

3-4 Linear Regression to Test the Relationship Between Independent Variables and Posttest Performance 77

3-5 Means and Standard Deviations for Time to Lesson Completion by Treatment Condition 78

3-6 ANOVA of Time to Lesson Completion by Treatment Condition 79

Abstract of Dissertation Presented to the Graduate School
of the University of Florida in Partial Fulfillment of the
Requirements of the Degree of Doctor of Philosophy

THE EFFECTS OF PROGRAM CONTROL, LEARNER CONTROL AND LEARNER CONTROL WITH ADVISEMENT LESSON CONTROL STRATEGIES ON ANXIETY AND LEARNING FROM COMPUTER-ASSISTED INSTRUCTION

By

Randall Phillip Coorough
May, 1990

Chairman: Lee J. Mullally
Major Department: Instruction and Curriculum

The purpose of this study was to examine the effects of three computer-assisted instruction (CAI) locus of instructional control strategies on anxiety and learner achievement. The three CAI locus of instructional control strategies examined were learner control (LC), learner control with advisement (LCA), and program control (PC). The LC and LCA strategies provided for learner control of lesson sequence, content review, answering questions, remediation of content related to incorrectly answered questions, and lesson termination. The LCA strategy provided advisement at each decision point in the lesson to guide learners in making instructional decisions. The PC strategy, which consisted of a pre-designed imposed control strategy, provided learners with no instructional control options. The instructional content selected for this study was a lesson addressing the effects of alcohol on the body. Each treatment consisted of the same basic tutorial CAI program with modifications in the locus of instructional control. To examine the effects of the CAI lessons on learner anxiety and achievement, split-plot and pre- and posttest experimental designs were used.

The subjects in this study (N=106) were undergraduate students enrolled in a general humanities course at the University of Florida. Subjects were randomly assigned to one of the three CAI treatment groups. All subjects completed the computer administered pre-assessment, CAI tutorial, and post-assessment. Pre- and post-assessments consisted of a 24-item pretest and posttest and an anxiety inventory. Anxiety was assessed using the 10-item State-Trait Personality Inventory S-Anxiety subscale. State anxiety was assessed prior to the CAI tutorial, during CAI and again following the CAI lesson.

The results of the study indicated that there was no significant achievement difference between subjects assigned to the PC, LC, and LCA locus of instructional control strategies. There was a significant decrease in subjects' state anxiety levels across measurement occasions that was the same across treatments. Finally, the LCA group required a significantly greater amount of time to complete the CAI lesson than was required by the LC group, yet had no associated achievement gain. This suggests that the LC strategy resulted in more efficient learning.

CHAPTER 1
INTRODUCTION

Microcomputers are rapidly becoming an important learning medium in education. Students are not only learning about microcomputers, but microcomputers have become an instrumental device for the delivery of instruction as well. In many educational settings, an important instructional application of the microcomputer has been for providing computer-assisted instruction (CAI) to students. Judd (1972) defined CAI as

> a general name for a number of methods of instruction in which a computer is programmed to accomplish the teaching functions of conveying information to the student, evaluating the student's understanding of this information, and providing feedback. (p. 37)

In CAI, computers are used as supplements to the more conventional teacher-based approach. Levin and Meister (1986) cite reduced costs and improved performance as two compelling reasons for the increased use of microcomputers in education. Computer-assisted instruction has been shown to be more effective in improving learner performance, attitudes, and in decreasing time required for instruction when compared to conventional instructional methods (Kulik, Bangert, & Williams, 1983; Kulik, Kulik, & Cohen, 1979). Clark (1983), however, suggested that any achievement gains attributed to the computer mode of delivery are most likely due instead to the instructional methods and designs used in the CAI courseware. Computers, however, can be used to more efficiently organize and present learning materials according to individual learner needs.

One of the advantages of CAI is the control that can be given to individual learners over the lesson presentation. Students using CAI may control the sequence, pace, depth of study, feedback, or style of instruction thereby greatly accommodating individual learner requirements (Gay, 1986). Instructional control of CAI courseware has generally taken two forms: (a) externally controlled (learner control) instruction where learners have full or partial control over CAI lesson presentation (e.g. lesson sequence, pace or feedback) and (b) internally controlled (program control) instruction where CAI is preprogrammed by the designers leaving no control to learners.

Much research has addressed the issue of instructional superiority of learner controlled versus program controlled CAI. Intuitively, many researchers have hypothesized that providing learners with greater control over instruction would result in greater individualization of instruction, greater achievement, and more positive learner attitudes toward instruction. The research, however, in general, shows that learners exposed to learner control do not achieve more, effectively utilize control options, or manage their time more efficiently when compared to students using program controlled CAI (Carrier, 1984; Clark, 1984; Merrill, 1980; Steinberg, 1977). A more recent review of the learner control research suggests that the empirical evidence provides only mixed support for the benefits of learner control (Milheim & Azbell, 1988). Despite the lack of conclusive evidence supporting learner control, Snow (1980) has expressed the need for continued research on the conditions of effective learner control.

Several researchers have suggested that achievement from learner controlled CAI is significantly enhanced when some form of advisement or "coaching" is provided to learners (Hannafin, 1984; Ross, 1984; Tennyson & Buttrey, 1980). This variation of learner controlled CAI, according to Hannafin (1984), provides learners with advisement based upon the learner's performance, while maintaining learner control over instructional variables in the lesson. Advisement may include recommendations for the number of practice items to complete, content to be reviewed, or sequence to follow. Milheim and Azbell (1988) in reviewing the learner control with advisement literature found that groups receiving advisement in general

1. had higher posttest means;
2. had more students reach mastery;
3. had longer time on task;
4. needed less instructional time; and,
5. needed fewer instructional instances.

Given the microcomputer's complexity and ability to provide individualized instruction, we must thoroughly understand the interaction between CAI design strategies and learners. Currently, computer-assisted instruction is designed and developed with little regard for learner characteristics that will ultimately determine the success or failure of students' performance in CAI. In large part, this is due to a lack of empirical knowledge on how best to design CAI based upon the interaction of instructional control strategies and learner attributes (Hannafin, 1984).

Many learner attributes have been implicated as playing a positive or negative role in learning via CAI. Previous research has indicated that students' prior achievement (Ross & Rakow, 1980), locus of control (Louie, Luick, & Louie, 1985), motivation (Seymour, Sullivan, Story & Mosley, 1987), and sex (Fennema & Sherman, 1977) are all contributing factors to a student's performance with CAI. Computer-assisted instruction research also indicates that anxiety, a very critical learner characteristic, can have profound implications for learning during programed instruction and CAI (Sieber, O'Neil & Tobias, 1977). A number of studies investigating the interactions between learner anxiety and CAI have indicated that certain levels of anxiety can be debilitating toward performance in CAI (Leherissey, O'Neil, & Hansen, 1971; O'Neil, 1972; O'Neil, Spielberger, & Hansen, 1969).

Clark (1984) suggested that efforts to alleviate anxiety which inhibits performance from computer-based instruction have largely failed. It is now generally agreed that instructional anxiety may have to be circumvented rather than cured. Highly anxious students tend to learn less and drop out of computer-based instruction more frequently than those experiencing only mild anxiety. Therefore, elements in CAI designs that may reduce anxiety would have both positive affective and cognitive implications (Clark, 1984).

While the effects of anxiety on CAI performance have been documented empirically, the interaction of CAI lesson control strategies, anxiety and resulting learner performance remains less clear however. It has been suggested that the more control a student has over a learning task, the better will be the performance and as control over learning material increases anxiety levels would decrease

(Sieber et al., 1977). A number of researchers have attempted to determine the effect of CAI on performance and anxiety when learners were given control of various instructional variables (e.g. memory support, presentation of visual stimuli, feedback, and sequence of instruction) (Collier, Poyner, O'Neil, & Judd, 1973; Gallagher, O'Neil & Dick, 1971; Hansen, 1974; Judd, Daubek, & O'Neil, 1975). These studies generally suggested that providing learners with control of the instructional variables did not necessarily facilitate performance over the imposed control groups, however, learner control to some extent, seemed to reduce a student's anxiety level.

The cognitive and affective benefits and limitations of learner controlled CAI are only just beginning to be understood. Research in this area clearly requires further study (Hannafin, 1984). Sound empirical research is required to further understand the effects of CAI lesson control design strategies on anxiety and learning performance in computer-assisted instruction.

Statement of the Problem

The problem under investigation in this study was to determine the effects of three CAI lesson control designs (program control, learner control, and learner control with advisement) on anxiety and learner achievement resulting from a CAI lesson.

Specific questions related to the problem are as follows:

1. Is there an interaction between locus of CAI instructional control strategy (program control, learner control, and learner control with advisement) and learner state anxiety levels?

2. Is there a relationship between pretest and posttest achievement scores?
3. Is there a relationship between on-task state anxiety levels and posttest achievement?
4. Is there a relationship between locus of CAI instructional control strategy (program control, learner control, and learner control with advisement) and posttest achievement?
5. Is there a relationship between gender and posttest achievement scores?
6. Does the relationship between pretest scores and posttest scores vary by treatment condition (program control, learner control, and learner control with advisement), or, in other words, is there a relationship between the interaction of treatment condition and pretest with posttest achievement?
7. Does the relationship between state anxiety level and posttest scores vary by treatment condition (program control, learner control, and learner control with advisement), or, in other words, is there a relationship between the interaction of treatment condition and on-task state anxiety level with posttest achievement?
8. Which instructional control strategy requires greater learning time to completion?

Justification for Study

The increased use of CAI in educational environments has also led to a plethora of recent studies proclaiming distinct learning advantages for CAI (e.g. Kulik, Bangert, & Williams, 1983; Kulik & Bangert-Drowns, 1983; Kulik, Kulik, & Cohen, 1980). Computer-assisted instruction effectiveness research, until recently, has primarily focused upon comparing CAI with the more traditional forms of delivering instruction. A meta-analytic study by Kulik et al.(1980) in which they analyzed hundreds of CAI studies, have indicated significant improvements in learning resulting from CAI when compared to more traditional instructional methods.

Computer-assisted instruction, as a new instructional innovation, remains popular among students and teachers. That enthusiasm, according to Jonassen (1988), has contributed much to its effectiveness. Clark (1983, 1985), in scrutinizing the comparative nature of CAI research, suggested that a variety of confounding effects such as novelty and enthusiasm, compromise the validity of the CAI research literature. Where CAI studies have been carefully controlled to avoid confounding by extraneous variables (e.g. novelty), any achievement gains resulting from CAI are most likely attributable to the instructional methods employed in the "software" (Clark, 1985). Clark (1983, 1985) further suggested that there is no reason for comparing CAI or any other instructional media to traditional instructional methods and he urges researchers to avoid these "gross comparisons."

Jonassen (1988) believes, however, that there is merit in comparing various CAI instructional design strategies and the interaction of them with learner attributes. Anxiety, an important learner attribute, has been shown to have negative effects on CAI learning outcomes (O'Neil, Spielberger, & Hansen, 1969; O'Neil, 1972; Leherissey et al., 1971). Clark (1984) suggested that researchers should develop CAI designs that attempt to circumvent anxiety by providing learners with increased instructional support. Others have suggested that allowing learners a degree of control during CAI lesson presentation may increase learning performance while decreasing anxiety (Sieber et al., 1977).

The research literature is limited with regard to the effects of CAI lesson control strategies and anxiety on performance. This issue is a complex one. Computer-assisted instruction courseware actively involves the learner in a highly sophisticated interactive dialog. It is this interactive dialog combined with the complex human characteristics of the learner that provides researchers with fertile ground for CAI inquiry. Research aimed at determining the most effective instructional courseware designs to optimize this dialog and provide for effective learning would significantly enhance courseware development efforts. More specifically, we know little of the effects of various locus of CAI lesson control strategies on anxiety and learning via CAI. This research study attempted to determine the effects of three CAI control strategies (program control, learner control and learner control with advisement) on learner performance and anxiety.

Hypotheses

On the basis of the current research, it was hypothesized that learners would benefit differentially from the three CAI lesson control strategies. It was also hypothesized that the learners' state anxiety levels would be dependent upon the CAI learner control treatment they receive and anxiety may impact learning. To test these hypotheses an experimental group design was developed. In order to compare the data provided by the study groups for statistical significance, the following null-hypotheses were identified:

1. There is no significant interaction between experimental treatments (program control, learner control and learner control with advisement groups) and occasion (pretask, on-task and post-task) for state anxiety levels.
2. There is no significant relationship between pretest scores and posttest achievement.
3. There is no significant relationship between on-task anxiety and posttest achievement.
4. There is no significant relationship between CAI instructional treatments (program control, learner control and learner control with advisement groups) and posttest achievement.
5. There is no significant relationship between gender of the subjects and posttest achievement.
6. There is no significant relationship between the interaction of CAI instructional treatments (program control, learner control and learner control with advisement groups) and pretest scores on posttest achievement.
7. There is no significant relationship between the interaction of CAI instructional treatments (program

control, learner control and learner control with advisement groups) and on-task state anxiety levels on posttest achievement.

8. There is no significant difference in time to lesson completion between the program control, learner control and the learner control with advisement groups.

Assumptions

The results of this research effort is presented on the basis of several assumptions. It is assumed that

1. Subjects responded honestly to the short form of the State portion of the State-Trait Anxiety Inventory.
2. Subjects undergoing the CAI instructional treatments did so in a serious manner.
3. Subjects completed the pretest and posttest honestly and to the best of their ability.

Limitations

The following limitation may have had an affect on this study: The researcher had no control over ensuring student's honest and serious participation in completing the CAI instructional treatments, State Anxiety measurements and pretest-posttest measurement.

Delimitations

This research study was delimited to

1. Volunteer male and female undergraduate students enrolled in the University of Florida Department of Health Science's Personal and Family Health classes.
2. Participating students were offered an extra credit incentive of four bonus points to be applied toward the final course grade.

Definition of Terms

The following terms have been defined to clarify their use in the study:

Anxiety is an unavoidable unpleasant experience having both negative physiological and behavioral effects often interfering with learner performance in instructional situations.

CAI (Computer-assisted instruction) is an instructional method based upon the two way interaction of a learner and a computer with the purpose of human learning and retention. The computer contains a stored instructional program designed to inform, guide, control, and test the student until a prescribed level of proficiency is attained (AECT, 1977).

Learner control is a lesson control strategy that permits learners to make decisions about program activities and procedures according to individually perceived needs (Hannafin & Colamaio, 1987).

Learner control with advisement is a lesson control strategy that provides learners with expert guidance while permitting learners to make decisions about program activities and procedures according to individually perceived needs (Hannafin & Colamaio, 1987).

Linear control is a lesson control strategy where instruction is presented in a nonalterable hierarchical sequence.

Lesson control strategies are control strategies that range along a continuum from complete learner control of lesson sequence, pace, feedback and other lesson features to total imposed control of lesson activities by the designer (Hannafin & Colamaio, 1987).

Program control is a locus of control strategy where the program's designers have imposed control of lesson activities. Learners generally follow a predetermined instructional sequence and are required to attain a minimum level of mastery.

Programed instruction is a term referring to a technique of, and materials for, instruction. Programed instruction provides an effort to package for the student the essential aspects of the tutorial method of instruction. It is a process of constructing sequences of instructional material in a manner that maximizes the rate of learning, and enhances motivation. Programed instruction frequently utilizes workbooks, or a mechanical and/or electronic device programed to help learners attain a prespecified performance level by presenting instruction in small steps, asking questions about each step and providing immediate feedback as to lesson performance. A key characteristic of programed instruction is that it enables students to progress at their own pace (AECT, 1977).

State anxiety is a transitory anxiety states (A-states) characterized by subjective, consciously perceived feelings of apprehension and tension, accompanied by or associated with activation or arousal of the autonomic nervous system (stress) (Spielberger, 1966).

Trait anxiety refers to a relatively stable personality trait (A-trait) implying a motive or acquired behavioral disposition that predisposes an individual to perceive a wide range of objectively nondangerous circumstances as threatening, and to respond to these with A-state reactions disproportionate in intensity to the magnitude of the objective danger (Spielberger, 1966).

Organization of Remaining Chapters

The remainder of this study is organized into four chapters. Chapter 2 contains a review of the literature related to the research problem specified in this chapter. The research methodology, experimental design and the analysis procedures used in this study are presented in Chapter 3. The results and analysis of data collected in the study are presented in Chapter 4. Chapter 5 contains a discussion of the research results along with conclusions, recommendations for future research, and a summary of the study.

CHAPTER 2
REVIEW OF THE RELATED LITERATURE

A technological revolution is taking place in our educational system. This revolution is based upon the application of scientific technology to instruction. Computer-assisted instruction is one of the most recent additions in this move toward technologized instruction. The promoters of this technology in education, such as Kulik & Bangert-Drowns (1983), are quick to promise the benefits of

> better, more comfortable, and faster learning--since students will be able to use technology to learn at their own pace and at their own convenience; opportunities to work with vastly richer materials and more sophisticated problems; unlimited, individual tutoring; and automatic measurement of learner progress. (p. 138)

This phenomenon is not new, it has occurred previously with the introduction of programed instruction, individualized instruction and more recently instructional video. However, the predictions of instructional superiority of these instructional technologies have rarely lived up to the promises made.

The question facing educational technologists is what will be the impact of computers in education. Many bold predictions have been made with regard to the potential of computerized instruction. Educators are beginning to question the usefulness of computer-assisted instruction as the primary application for this technology (Roblyer, 1988). Since the initial instructional applications of computers in education a large body of research has begun to accumulate suggesting impressive benefits resulting from computer-based instructional methods (Kulik et al., 1980). Roblyer (1985) in reviewing past CAI uses from 1965-85 suggested that the effects on learning vary greatly depending upon courseware design and implementation and that CAI may not be as effective as some other less expensive nontraditional methods. Others dismiss much of the existing instructional computer research as being of poor design and providing confounded findings due to its use of comparative methods (Clark, 1983).

In response to the inappropriate comparative nature of much of the computer-based instruction research, Clark (1983, 1985) and Winn (1980) have suggested a new direction for researchers to pursue. This new research should focus not on the medium, but rather on the instructional message designs, characteristics of the instructional methods and learner variables (e.g. learner attributes and aptitudes). It is the "soft technologies" (instructional designs and methods) that will ultimately determine the success of this new medium. The hardware, while providing powerful capabilities, has no effect on learning (Clark, 1983).

Eliminating the computer-based instruction research that is comparative in nature leaves a relatively small body of empirically sound studies. From these studies the complexity of the interaction between learners, instructional methods and computer-based instruction becomes apparent. Researchers are left asking many questions about how to design and develop more efficient and effective computerized instruction based upon the interactions of CAI with the complex characteristics of the human learner.

To review the literature in this area, Chapter 2 is divided into three sections. The first section provides an overview of the current literature related to computer-assisted instruction. The instructional uses of computers, studies suggesting the effectiveness of computer-assisted instruction and the various instructional designs used to design and develop computer-assisted instructional courseware are also discussed. The second section is a review of anxiety theory and a discussion of the impact of anxiety in instructional situations. The third and final section provides a discussion of the anxiety research as it relates specifically to computer-assisted instruction.

Computer-Assisted Instruction

A recent literature search of computer-based instruction (CBI) resulted in more than 500 studies being located (the majority of which were CAI) that compared CBI to conventional teaching (Kulik et al., 1980). Given the current enthusiasm and wide spread use of computers in schools and the nine year period since the Kulik et al. (1980) review, the volume of CBI research has surely increased considerably. Due to the inappropriate methodological nature of much of the CBI research as discussed by Clark (1983, 1985), this review with a few exceptions will present only non-comparative CAI research investigations.

CAI Instructional Uses

Computers are used in a variety of different ways in the classroom. Computer-assisted instruction is only one of many educational uses of computers. Alessi and Trollip (1985) have identified several other applications of computers in education besides CAI. These uses may include (a) administrative uses (scheduling, grading, accounting), (b) to teach programming, and (c) as a production tool (word processing). Jonassen (1988) says it is important to distinguish between teaching about computers and teaching with computers. Teaching about computers often involves making students computer literate or teaching them computer programming skills while teaching with computers provides students with an alternative instructional delivery method to traditional teaching techniques. Computerized instruction is typically used as a supplement to more traditional instructional methods, however, occasionally it may substitute for conventional instruction.

Computer-assisted instruction programs are typically classified according to the instructional role of the program. Computer-assisted instruction as identified by O'Neil and Richardson (1977) includes drill and practice, tutorial and simulation type programs. Drill and practice and tutorial instruction have evolved from the programed learning instructional designs (stimulus-response-feedback) (Jonassen, 1988). The design of drill and practice courseware is an example of linear programed instruction while tutorial courseware represents branching programed learning design. The tutorial method dictates a greater degree of learner cognitive processing through the stimulus-response-feedback paradigm. In contrast, the simulation mode of CAI is not based upon the programed instruction design, but rather on recreation of real-life situations requiring learners to respond with an appropriate course of action. In addition to drill and practice, tutorial and simulation CAI, Alessi and Trollip (1985) suggest that instructional games represent an important CAI instructional methodology.

Drill and practice CAI is primarily used to supplement regular instruction. In drill and practice, concepts presented via regular instruction can be practiced through repeated presentation of questions or problems until the learner reaches a prescribed criterion level. Lessons presented through this form of CAI can be tailored to meet the deficiencies of individual learners and provide immediate corrective feedback. By assigning students to CAI drill and practice, teachers are free to perform other worthwhile instructional activities. High quality CAI drill and practice programs can often remove the drudgery involved in rote learning tasks as well as enhance the efficiency and effectiveness of learning.

Computer-assisted instruction tutorials, unlike drill and practice, are often designed as a stand alone instructional methodology. Tutorials carry on an interactive dialog with learners. Tutorial programs teach the subject matter and evaluate the students performance. Sophisticated tutorials often present information, ask questions and based upon student responses, make instructional decisions as to whether to move on, review or terminate instruction (Alessi & Trollip, 1985). Well designed tutorials lead students through ever increasing levels of content difficulty while continually providing corrective feedback and alternate representations of the conceptual content (O'Neil & Richardson, 1977).

Computer-assisted instruction simulations are computer programs that imitate real or imaginary situations in order to teach a student about it. The consequences of any action simulate the results of an action in the real world. The realistic nature of the simulation provides for greater meaningfulness for learners and results in higher intrinsic motivation. Simulations are useful when expense, danger, or lack of time or materials make enactment of the real life situations impossible (Roblyer, 1988).

Computer-assisted instruction games possess extremely beneficial motivational qualities. Computer-assisted instruction games typically have some concept or skill embedded in them which students must continually master to play (Alessi & Trollip, 1985).

Advantages and Disadvantages of CAI

Chambers and Sprecher (1984) suggest that the most widely accepted benefit of CAI is that it involves the individual actively in the learning process. Students must continually respond and interact with the electronic tutor rather than being the passive recipient of information. This continual interaction increases attention and on-task behavior which greatly facilitates learning. A second important characteristic of computer-based learning systems is that they provide students with the ability to progress at their own pace, which has important implications for both slow and fast learners.

Wager and Gagne (1988) in suggesting guidelines for computer-based instruction, cite two features that set the computer apart from other learning media. First, the computer provides designers with control over display capabilities allowing for "stimulus elaboration" that have the effect of enhancing learning and retention. A second feature is that computers provide for active responding by learners and based upon learner responses provides additional information and immediate corrective feedback. Learners should be provided with feedback of not only the correct response but guidance as to the process of arriving at the correct response.

Computer-assisted instruction can free teachers so that they may attend to other learner needs (Chambers & Sprecher, 1984). By periodically assigning individual or groups of students to CAI, teachers can thereby devote additional time and effort to providing more personalized attention for needy students.

There are three major disadvantages of CAI according to Chambers and Sprecher (1984). First, there is a lack of teacher training in the effective implementation of CAI into classrooms. Teachers considering implementation of CAI often lack the necessary computer expertise or knowledge of proper CAI use and frequently experience feelings of technological anxiety. Secondly, there is a lack of availability of good quality CAI courseware. Commercially developed CAI courseware rarely follows sound instructional design procedures, or empirical knowledge about how best to design courseware based on the research, and even more rarely does it receive any type of instructional effectiveness evaluation (Vargas, 1986). Thirdly, the cost of computer hardware, CAI courseware, and human resources needed to implement CAI is prohibitive. While the costs of hardware and software have continued to decline, the prices are often beyond the limited financial resources of many schools.

CAI Effectiveness

A number of meta-analytic studies (Kearsley, Hunter, & Sidel, 1983; Kulik et al., 1980; Kulik et al., 1983) generally suggested that computer-based instruction results in more student achievement than do traditional means of instruction. In addition, these comparative studies suggest that CAI has also been found to have positive effects on learner attitudes and in reducing the time for teaching-learning (Kulik et al., 1983). Clark (1983, 1985), who sharply condemns this comparative research, disputes these findings and claims that poor experimental designs and confounding of uncontrolled extraneous variables are responsible for any differences. Clark (1983) goes on to say that there is no theoretical reason for comparing traditionally delivered instruction to CAI or any other mediated instructional method. There are, however, according to Clark (1983), significant reasons for comparing CAI instructional designs for creating courseware.

CAI Instructional Designs

Instructional design represents a systematic method of developing a plan, or using Reigeluth's (1983) metaphor, a "blueprint" for instruction. Instructional designers base the instructional plan and subsequent design of the instructional sequence on analysis of learning needs, learner characteristics, and situational factors (Jonassen, 1988). What results is a design specifying how instruction ought to be provided based upon learning theory and knowledge about instruction and methods. It is Roblyer's (1988) recommendation that courseware designers in particular utilize this systematic instructional design approach in developing CAI courseware.

The computer as an instructional delivery device offers instructional designers a myriad of options. Computer-assisted instruction can be designed using various presentation formats (e.g. drill and practice, tutorial, and simulation), feedback options, interaction variations and management options (Hannafin, 1984). It is because of these powerful and varied capabilities and the lack of knowledge on how best to design CAI courseware given these capabilities, that many attribute the poor state of educational courseware. If the outlook on CAI is to improve, Roblyer (1988) suggested that raising courseware quality and providing for more individualized learner needs must become a primary focus.

As previously mentioned, an advantage of CAI over less interactive methods of mediated instruction is the capability of systematically providing for differing individual learner characteristics and aptitudes. Carrier, Davidson, and Williams (1985) suggest that no technology provides more opportunities to respond to individual learner needs than the computer.

A popular instructional design for adapting CAI to individual needs is to allow students to exert control over the learning environment. Various degrees of control or "locus of instructional control strategies" exist. Locus of control strategies range from fully learner controlled to program controlled where learners are given no control options. In learner control methods students might be given control over lesson pacing, sequence, methods, or other instructional variables such as feedback. Carrier et al. (1985) suggest that while learner control may be intuitively appealing, how control should be utilized, to what type of learners, and under what instructional conditions are important concerns we know little about. In order for instructional designers to produce effective CAI courseware, educational researchers must address these issues.

Locus of Instructional Control Strategies

Locus of instructional control strategies have been implicated as having both affective and cognitive consequences during the learning process regardless of the instructional medium used (Hannafin, 1984; Mager, 1961; Mager & Clark, 1963; Milheim & Azbell, 1988; Reiser & Sullivan, 1977; Steinberg, 1977). Hannafin (1984, p. 6) describes instructional locus of control as a "continuum ranging from fully externally controlled to completely internally controlled." Externally controlled (program controlled) instructional methods are designed as linear fixed sequence delivery systems such as instructional video. Learners are directed along a predetermined path through external designer control. Internally controlled (learner controlled) instruction, on the other hand, provides students with control of an instructional variable contained in the lesson (e.g. sequence, pace, or feedback). Learner control "is demonstrated in lessons where individuals control the path, pace and/or contingencies of the instruction, typically by specifying choices among a range of designer-embedded options (Hannafin, 1984, p. 6)".

Locus of instructional control has been the subject of extensive study and particularly in relation to learning via computer-based instructional systems (Hannafin, 1984; Milheim & Azbell, 1988; Steinberg, 1977). The locus of instructional control options that can be provided to learners through computer-based instruction is one of the medium's extremely powerful capabilities. Students may be provided control of the instructional sequence, pace, feedback, depth of study, and a great many other instructional variables as selected by courseware designers. The greater the learner control incorporated into the courseware, the more sophisticated the nature of the interactive dialog. However, the amount and type of instructional control given to learners is affected significantly by the learning task and characteristics of the student (Hannafin, 1984). A review of the instructional control research is provided below.

Learner Controlled Instruction Research

Some of the earliest reported studies concerning the ability of students to control their own learning were conducted by Mager (1961) and Mager and Clark (1963). Mager (1961) showed that learner-generated lesson sequences, while similar to other learners are quite different than instructor generated sequences. Mager found that the more control that the learner exerted over the lesson sequence, the greater the learner's motivation level. While Mager did not use a computer interface, the control question raised in his study might well be applicable to CAI learning experiences.

In a similar study with adult learners, Mager and Clark (1963) sought to determine the ability of students to control their own learning. The results of their research indicated again that some adult learners tend to be able to direct their own learning when given instructional control of their curriculum. These initial positive findings in learner control led to a number of research studies that further examined the effectiveness of learner control of different instructional variables in programmed and computer-assisted instruction.

Learner control of lesson pacing

In a Personalized System of Instruction course in Introductory Psychology, Fernald, Chiseri, and Lawson (1975) studied the effects of student pacing versus teacher pacing. Students were assigned to student-paced or teacher-paced treatments. In the student paced treatment, students could take quizzes as rapidly or as slowly as they liked allowing them to control the pace of lesson completion. Teacher-paced students were required to take quizzes for assigned units at specified time periods. The researchers found that when students were allowed to control the pacing of quizzes they scored significantly higher than the teacher-paced groups. Additional analysis revealed that students held moderate to strong preferences for student pacing as well.

Santogrossi and Roberts (1978) in examining student control of lesson pacing in a noncomputer-based Personalized System of Instruction also found some positive results from learner control. According to Santogrossi and Roberts, students who benefited the most from self-paced instruction,

> in general, tend to be more intelligent, score lower on measures for need of approval, have higher GPA's, have had higher high school percentile ranks, have higher aptitude test scores, score higher on the midterm and final examinations, and receive higher course grades than slower peers. (p. 32)

Reiser and Sullivan's (1977) investigation of the effects of a self-pacing strategy (learner control) in a Personalized System of Instruction did not support learner control. In the study two treatments were utilized. In one treatment (self-paced) students were allowed to take each quiz in the course at whatever pace he chose. A second treatment (instructor-paced) required students to pass each quiz by a prespecified target date set by the instructor. The rates of student withdrawal were significantly higher for the self-paced group than from the instructor-paced group. There were no reported significant differences between groups for attitude or achievement. The researchers hypothesized that failure to maintain a steady quiz-taking pace and poor performance on the quizzes were the factors associated with withdrawal from the course. Students did not effectively use learner control of pacing, thereby resulting in a greater withdrawal rate.

In a more recent study of lesson pacing in a computer-based instruction program, Belland, Taylor, Canelos, Dwyer, and Baker (1985) reported that self-paced instructional methods may not always be the best way to address individual learner characteristics. In their study, Belland et al. (1985) reported experimental results that supported moderate levels of external lesson pacing. Subjects in the self-paced instructional group performed more poorly, in terms of amount learned and performance competency, than subjects in the moderately externally paced instructional program condition.

Learner control of lesson sequence

Learner control of lesson pacing has been the subject of a number of investigations. Newkirk (1973) compared two versions of a computer program to teach the structure and language of a hypothetical CLIP computer. The two versions of the program were a fixed linear sequence where learners had no instructional options and a learner controlled version where subjects had complete freedom of instructional sequence and were required to study only that material they deemed necessary. While immediate posttest analysis showed no significant differences on performance and attitude between the two groups, there was a significant difference in long term retention (two weeks) with the learner control group scoring higher.

Similar positive findings were reported by Mayer (1976a). In a study of subject control of frame order Mayer (1976a) found that subjects who controlled the order of presentation of frames performed better on novel transfer relative to experimenter-control subjects. One hundred sixty nonprogrammers learned a computer programming language in a noncomputer instructional lesson. Mayer reported that learner control of frame order may have resulted in "deeper, more active encoding, which allowed subjects to struggle harder to relate the text to their own experience rather than memorize the information as presented (p. 149)."

In a similar study of locus of instructional control over lesson sequencing in a computer-assisted instructional sequence, Campanizzi

(1978) provided support for the idea that students benefit from having a great deal of control over their own learning. In the study, Campanizzi found significant positive differences in achievement gains under a learner controlled computer-assisted instructional sequence when compared to subjects in a program controlled treatment.

Hannafin and Colamaio (1987) examined the effects of variations in lesson control and practice on the learning facts, procedures, and problem-solving skills during computer-assisted interactive video. Learners were randomly assigned to one of three instructional control groups: designer control (program control), learner control with "coaching", and linear control. Posttest measures indicated that either of the interactive versions of instruction (learner and program control) were superior to the linear design.

Fry (1972) reported results that were less than supportive of learner control of instruction. Fry examined the effect of student characteristics and student control of learning in a simulated learner-computer environment. In the study 192 college students were given degrees of control over the programming (sequence) of their own learning. The results showed that high aptitude-high inquiry subjects learned significantly more under a high degree of learner control, and high aptitude-low inquiry subjects learned significantly more under a low degree of learner control. Fry concluded that subjects learning under a high degree of learner control learned the least, although they did form the most favorable attitudes toward the method of instruction.

In contrast to Fry's (1972) findings, Gray (1987) reported that learner control resulted in increased content comprehension while at the same time producing more negative attitudes toward CAI. In the CAI study, Gray examined the effects of two types of sequencing control, (a) a linear (program), and (b) a flip (learner) sequence condition. Results indicated that students in the flip sequence condition performed better on a comprehension measure but not on a retention measure than learners in the linear condition. In addition, having greater control over CAI sequence did not result in more positive attitudes, but rather, resulted in a more negative attitude towards the CAI.

In a study of the effects of varying degrees of learner control over CAI lesson sequence and selection of instruction, Judd, Bunderson and Bessent, (1970) reported no favorable advantages for the learner controlled CAI conditions. In fact, subjects in the learner control conditions used the control to avoid the more difficult segments of the lesson while spending more time on the easier segments. The researchers suggested that learners being given instructional control over lesson sequence and selection of instruction should be more familiar with the content and trained in using control options.

In an investigation of learner control of sequence in a CAI science lesson, Oliver (1971) reported similar no significant differences among locus of control treatment groups. Oliver used a group of 52 undergraduate students randomly divided into (a) a forced sequence group, (b) a learner controlled sequence group, and (c) a yoked control group (members were paired with a subject from the learner control group and given the same instructional sequence they utilized). It was hypothesized that as subjects deviated from the optimal sequence as determined by an expert, posttest scores would decline. In addition, learner control subjects would have more positive attitudes toward instruction and would out perform the yoked control subjects. Posttest performance analysis revealed no significant difference indicating that learner control of sequence resulted in no obvious advantage with regard to performance or attitudes.

In an additional study, Balson, Manning, Ebner, and Brooks (1984/85) compared instructor controlled versus student controlled computer-assisted interactive video instruction for training military paramedics. The lesson was designed to teach methods of administration of intramuscular injections. Study results revealed that the instructor-controlled group required less instructional time than the student-controlled group. No differences were reported for achievement. The researchers concluded that instructor-controlled instruction was more efficient.

Learner control of other instructional variables

Fisher, Blackwell, Garcia, and Greene (1975) researched the effects of student control and choice on task engagement in a CAI math lesson. A group of 38 study subjects were assigned to either a choice (learner control) or a yoked control condition. The choice condition allowed selection of arithmetic problems (number of problems and difficulty level), while the yoked control condition allowed no student choices. Analysis of the study results indicated that learners in the choice condition had higher task engagement for easier problems and lower task engagement for more difficult problems. In addition, learner control was associated with students working fewer problems per day.

Gay (1986) investigated the interaction of learner control of lesson pace, sequence, presentation mode, practice and depth of study with prior conceptual understanding in a computer-assisted video instruction. The general hypothesis of the study was that subjects who had some prior conceptual understanding would learn best when given learner control and subjects with little or no prior conceptual understanding would learn best if given more structure through program control. Students were assigned to treatment conditions based upon pretest scores (half of low scoring group and high scoring group to each treatment). Results supported the investigator's original hypothesis. Low aptitude subjects in the learner control group had significantly lower posttest scores than high aptitude subjects in both the program controlled and learner controlled conditions and low aptitude subjects in the program controlled treatment. The efficiency of high aptitude subjects was significantly greater than subjects of any other treatment group.

Merrill (1979, 1980) provided reviews of the research on the use of learner control in computer-based learning situations. Merrill indicated that while use of learner control strategies in computer-based instruction did not result in any drop in student learning, there was also no clear indication that the overall use of learner control caused any increase in student achievement, efficiency, or attitude toward instruction. While the research did not favor learner controlled instruction over other control strategies, Merrill (1979, 1980) stressed the importance of students controlling their own cognitive processing of the information presented to them. Merrill also suggested that the challenge is not whether to use learner control but rather how to help each student best use the learner control that is available.

In addition, Snow (1980) suggested that learner control generally has failed to produce positive effects because we know little about the types of learners who should be granted control and under what conditions. Snow contends that if certain abilities or personality characteristics are known to lead to increased performance under learner control, we can give students possessing those abilities and characteristics decision making power.

Adaptive control studies

In response to the equivocal results of learner control research, Tennyson (1975) proposed an adaptive control strategy that would prescribe instructional instances and contingencies by analyzing a student's on-task error patterns. Tennyson's hypothesis was that by diagnosing individual student needs and attributions, an adaptive control strategy could be constructed to provide an individualized instructional treatment. Two sources of data for formulating adaptive designs include pretask measures and on-task measures. Tennyson and Rothen (1979) in critiquing instructional management designs, suggested that an adaptive control strategy would be more effective than either learner control or program control strategies in the design of computer-based instruction. A number of investigations have been conducted regarding adaptive control strategies.

In testing Tennyson's adaptive control strategy, Ross and Rakow (1981) investigated the effects of a learner control versus adaptive program control strategy in self-paced lessons in a noncomputer-based instructional situation. Subjects completed math rule lessons in which the number of supporting examples were adapted to pretest scores through program control, selected by learners (learner control) or kept constant (nonadaptive). On posttest measures adaptive program control means were significantly higher while learner control means were lowest.

In continuing the research, Tennyson and Buttrey (1980) investigated whether providing advisement during learner control or adaptive control (program control) in a CAI coordinate concept learning task would improve learner performance. One hundred thirty nine 12th graders were randomly assigned to one of four CAI treatments: Learner control with advisement, learner control without advisement, adaptive control with advisement, and adaptive control without advisement. In the adaptive control groups the number of instances presented to each student was based on pretest assessment and on-task performance. In the learner control group students determined whether to continue receiving examples or to go to the posttest. Advisement was provided to inform students of progress toward objectives and recommended learning sequence. The data analysis revealed that subjects in the adaptive control groups had significantly higher posttest scores than students in the learner control groups. Scores were also significantly higher for subjects in the advisement groups when compared to the no advisement conditions. Further analysis revealed that the learner control group without advisement had the lowest posttest scores, while the other three groups were equal. All groups achieved mastery except for the learner control group. These findings were supportive of Ross and Rakow's (1981) previous findings.

In a study of adaptive control and learner control of learning time and content sequence in a CBI concept learning task, Tennyson, Park, and Christensen (1985) reported that an adaptive-controlled display time (display time of instructional frames was adapted to each learner based upon an analysis of each learners' instructional needs) group needed fewer examples and less instructional time and performed better on the posttest and a retention test than did a learner-controlled group. Tennyson et al. (1985) indicated that posttest performance of subjects in the learner-controlled condition averaged 68%, while those in the adaptive treatment averaged 81%. The researchers concluded that without some sort of advisement the learner has too many possible interferences and too few adequate memory management processes to maintain control over pacing the instruction.

In continuing the adaptive control research, Ross (1984) explored the effectiveness of placing various adaptive design options under learner control in a number of studies. One study sought to determine whether students given learner control could make their own decisions about usage of instructional resources in a computer-based learning activity. The study included four treatment groups: (a) program control with instructional support adapted to pretest scores; (b) learner control of instructional support; (c) standard instructional support (constant support rate of five examples per rule); and (d) lecture. Experimental results revealed that the program control group significantly surpassed learner control and lecture on learning performance. Program control was also associated with longer learning times. Learner control was associated with the lowest performance overall which may have been due to learners selecting much fewer examples than prescribed under other conditions. Ross (1984) concluded by suggesting that learners may "lack the experience and sophistication to know which prescriptions are appropriate for accomplishing task objectives, and consequently, may make poor decisions (Ross, 1984, p. 46)."

Learner control with advisement

Due to the complexity of adaptive CAI designs requiring considerable expertise in CAI development, CAI researchers suggest that a variation of learner controlled instruction called learner control with advisement may be a promising design strategy for CAI development (Hannafin, 1984). Learner control with advisement is a methodology where learners are able to make decisions as to content, sequence, etc., while the computer program makes suggestions for some of those choices. Such suggestions or "coaching" may be necessary as a number of researchers suggest that learners make poor instructional control decisions (Carrier, 1984; Clark, 1985; Ross, 1984).

Tennyson (1980) investigated the instructional control strategies of advisement and learner control in a computer-based concept acquisition task. In the study 135 college students were randomly assigned to three conditions: adaptive control (no student control), learner control (student control on amount and sequence), and learner-adaptive control (student control on amount and sequence with advisement on diagnosis and prescription). Data analysis showed that for college students, the advisement condition resulted in significantly higher performance than the learner control condition and needed less instructional time and fewer instructional instances than the adaptive control condition. Posttest results indicated that students in both the learner-adaptive control and adaptive control condition attain 74% correct while subjects in the learner-control condition responded to only 52% of the posttest items correctly.

In a later study, Tennyson (1981) reported similar findings from two studies indicating that students can effectively manage their learning needs in a computer-assisted instructional system when provided with continuous advisement information about their achievement and instructional needs in relation to the instructional objective. In the first study Tennyson (1981) reported that high school students receiving instruction via a learner-adaptive-control management strategy that included advisement, performed significantly better on the posttest assessment than subjects in a learner-control condition (posttest scores 80%+ for the learner-adaptive-control management strategy and 52% for learner-control condition). Tennyson (1981) indicated that a second study replicated the effectiveness of the learner-adaptive-control strategy by showing that students were able to make better self-assessments and management decisions during three instructional units and scored higher on posttest assessment than either a learner-partial-control or learner-control condition (posttest scores were 82%, 71% and 53% respectively). Tennyson concluded by stating that "a learner-control condition can be a valuable instructional management system, especially for CAI, if students receive sufficient information and advisement about their learning development: information that continuously shows them what progress they have made toward mastery of the objective and provides meaningful advice on appropriate stimuli necessary to obtain mastery (p. 437)."

Laurillard (1984) conducted a pilot study of computer-assisted interactive video and learner control of sequence, mode (active versus receptive learning), number of practice items and practice time. The results indicated that students can make use of instructional control suggestions and like being given advice on appropriate sequence and strategy. Learner control with advisement also resulted in more positive attitudes toward instruction.

In a study of adaptive advisement on perception in learner controlled computer-based instruction using a rule-learning task, Johansen and Tennyson (1983) sought to determine whether learner control of instruction could be facilitated by affecting student's perceptions of learning need. Subjects in one treatment condition were provided with advisement concerning learning performance and needs (amount and sequence of content) in relationship to mastery level required and were allowed to make instructional decisions. Two additional treatment groups consisted of a partial learner control and a full learner control condition. The posttest performance indicated that subjects in the advisement-learner-control group surpassed the mastery criteria of 75% by averaging 82%. However, subjects in the learner control treatment were far below the mastery criterion, while partial learner control treatments attained only 67% of mastery criteria. Study results indicated that learner control can be a powerful management strategy for computer-based instruction when the learner is advised of learning needs in relation to predefined levels of mastery.

Goetzfried and Hannafin (1985) reported negative findings regarding the learner control with advisement strategy. In studying the effect of three locus of CAI control strategies on the learning of mathematics rules by seventh grade students, Goetzfried and Hannafin found no differences in achievement between treatment conditions. An adaptive control, learner control with advisement and program control condition were compared. While no achievement differences were found, both instructional time and learning efficiency were significantly affected. The adaptive and advisement strategies required greater learning time with no associated achievement gains. The program control condition resulted in comparable learning with less instructional time as well. Goetzfried and Hannafin attributed the study effects to a general lack of background knowledge in the content area and less effective ability in making appropriate instructional judgements.

Anxiety

Anxiety has long been recognized as a major psychological factor in learning. A substantial body of research has been established linking high anxiety to the ability of learners to benefit from instruction (Tobias, 1979). Sieber et al. (1977) have provided a review of anxiety, learning and instruction in a variety of settings, ranging from conventional classroom teaching to individualized instruction, programed instruction and computer-assisted instruction that has implicated anxiety as interfering in student achievement from a variety of instructional methods. A recent upsurge of interest in individualized instruction has led to an increased interest in the factors affecting the individual learner such as anxiety. Because of the complex nature of the construct of anxiety, many theories of anxiety have been posited. An overview of some of the more popular theories are discussed below.

Theories of Anxiety

Some of the earliest psychological cogitations concerning the construct of anxiety were expressed by Sigmund Freud. Freud saw anxiety as "a specific state of unpleasure accompanied by motor discharge along definite pathways" (Freud, 1936, p. 70). These discharges (heart palpitations, sweating, tremor, vertigo, and numerous other physiological and behavioral manifestations (Spielberger, 1966)) are responsible for anxiety's unpleasurable nature by causing a state of excitation, however, these same discharges over time relieve feelings of anxiety. Freud cited the traumatic experience of birth as the prototypic anxiety state. Anxiety initially arose as a response to a situation of danger, which in the case of birth was a gross disturbance of the physical and emotional feelings of the newborn. Anxiety serves a mobilizing function to the organism when confronted with a perceived harmful or dangerous situation. This anxiety is a reaction of the "Ego" to stimulation it is unable to control. Through the psychological process of association, we attach anxiety to the expectations of danger. In response to anxiety, the individual mobilizes the ego defenses to protect himself from painful or noxious situations. (Freud, 1936).

Anxiety serves a very important life sustaining function by mobilizing ego defenses, yet on the other hand can produce quite debilitating psychological and physiological effects in relatively harmless situations. Freud believed that when an individual encounters a dangerous situation that is new to him, he responds with an anxiety state that is commensurate to a reaction of an earlier danger instead of a reaction being appropriate to the present one. This state of anxiety can then be replaced by more appropriate measures for dealing with the danger as we analyze the danger situation. Freud saw two possible responses to anxiety: (a) one being inappropriate and inexpedient, in response to a new situation of perceived danger, and (b) a useful one, as a means of giving warning of and averting a danger situation.

Freud (1936) differentiated between objective anxiety and neurotic anxiety on the basis of whether the source of the danger was from an external source or from internal feelings. Objective anxiety was regarded by Freud as being equated with fear. This type of anxiety involved a complex internal reaction to a perceived situation of potential harm or danger. This real danger situation exists in the external world, is perceived as threatening, and therefore evokes an anxiety reaction. The more threatening the situation, the stronger the anxiety response.

Neurotic anxiety, like objective anxiety, produces feelings of fear and physiological arousal. However, neurotic anxiety originates from an internal rather than external source. In the case of neurotic anxiety the source of danger is usually from the individual's own repressed sexual or aggressive impulses (Spielberger, 1966). Freud (1936) suggested that neurotic anxiety is a product of traumatic experiences such as birth, the loss of a loved one, or aversive conditioning occurring in childhood. Most neurotic anxiety is experienced as "objectless" since most cues associated with the punished impulses remain repressed. Thus, neurotic anxiety is the result of a process where internal impulses evoke an anxiety reaction that signals the danger of additional punishment if the impulses are expressed. We all experience some amounts of neurotic anxiety from time to time, however, when neurotic anxiety occurs in pathological amounts, it results in the clinical syndrome anxiety-neurosis (Freud, 1936).

Hull (1943) and later Spence (1958), proposed a theory of anxiety that was built around Hull's theory of learning. Hull's learning theory seeks to explain and predict the learning of new responses. Hull proposed that the excitatory potential (E), or likelihood of a response, is a multiplicative function of the strength of the learned habit (H) and the strength of the learner's total effective drive state (D). Hull's formulation regarding these basic variables affecting the occurrence of a response is:

$$E= f(H \times D)$$

This formula allows closer analysis of the process of learning and performance. The strength of habits exhibited in any given situation are determined by the subject's previous experience in similar circumstances. Total effective drive state is affected by the total of all individual need states that exist at a given point in time, the stimulus intensity and the learner's emotional responsiveness. Emotional responsiveness is the term Hull equated with anxiety.

Hull (1943) and Spence (1958) believed that emotional responsiveness is an important learner characteristic because there are consistent individual differences in the strength of an emotional response to a stimulus of a given intensity. Highly emotionally responsive persons tend to respond more strongly to stimuli that they perceive as threatening. In addition, they express and demonstrate more extreme emotional responses to stressful situations and have faster and more vigorous coping mechanisms (Sieber, 1977). Learners who are highly emotionally responsive or anxious are more likely to make a well-learned response given a stimulus situation. Often times, however, learners are requested to provide a correct response from a group of competing responses. Sieber (1977) suggested that high anxiety and emotional responsiveness only adds to the confusion and difficulty of such tasks.

In furthering the experimental research on anxiety, Taylor (1953) developed the Manifest Anxiety Scale (MAS) as a measure of the extent to which persons admit possessing overt symptoms of emotionality. The MAS has since been used extensively as a measure of drive level (D) as it relates to Hull's learning theory (Spielberger, 1966). The premise of the instrument is that subjects with high MAS scores are more emotionally reactive and therefore, higher in drive than persons with low scores. The instrument was a large step forward that enabled researchers to examine the relationships between anxiety and other aspects of personality, behavior, and socialization (Sieber, 1977).

The MAS subsequently resulted in the development of the Spence-Taylor theory of emotionally based drive or as its more commonly called Drive Theory (Spence, 1956, 1958; Taylor, 1956). Drive theory is based upon Hull's (1943) theory that the strength of a response is a multiplicative function of drive state and habit strength. Spielberger (1975) reported that by the mid-1950's there was extensive evidence of the MAS's construct validity as an index of drive level and predications derived from Drive Theory were supported with regard to the performance of high and low anxiety subjects in a variety of learning situations. Individuals with high MAS scores (high drive) tended to demonstrate higher performance on tasks involving a single dominant response such as eyelid conditioning (Spielberger, 1975). Spielberger (1975) indicated that in complex learning tasks where strong error tendencies competed with the correct response, high anxiety learners performed more poorly than low anxiety learners. Thus, in simple learning tasks with few competing response tendencies, high anxiety facilitated performance, while on complex learning tasks where strong competing error tendencies were elicited, high anxiety resulted in poorer performance.

State-Trait Anxiety Theory

In generating a new conception of anxiety as a personality characteristic, Spielberger (1966) has suggested that the research findings indicate anxiety commonly takes two distinct forms: anxiety as a transitory state and anxiety as a relatively stable personality trait. According to Spielberger (1966)

> Anxiety states (A-states) are characterized by subjective, consciously perceived feelings of apprehension and tension, accompanied by or associated with activation or arousal of the autonomic nervous system. Anxiety as a personality trait (A-trait) would seem to imply a motive or acquired behavioral disposition that predisposes an individual to perceive a wide range of objectively nondangerous circumstances as threatening, and to respond to these with A-state reactions disproportionate in intensity to the magnitude of the objective danger. (p. 16-17)

To measure the psychological construct of state—trait anxiety Spielberger, Gorsuch, and Lushene (1970) developed the State—Trait Anxiety Inventory to provide a self-report measure of both state and trait anxiety. The 40 item inventory consists of two scales for measuring each of the anxiety types. The two parts of the anxiety inventory consist of questions that ask how the respondent feels in general (trait anxiety) and the extent to which they are experiencing each kind of feeling at that time (state anxiety). In order to adapt the state anxiety portion to computer-based learning tasks, and not interfere with learning performance, the original 20-item state anxiety scale was abbreviated to ten items. The short version provided a briefer state-anxiety measure, which could be measured in less than a minute, while still providing reliable and valid information (for a discussion of the short form of the state-anxiety scales reliability and validity see Chapter 3).

Spielberger (1966) indicated that higher levels of trait anxiety are usually associated with higher levels of state anxiety. However, this may not be true in all cases. For example, if a high trait-anxious student is presented with a difficult and complex learning task, it may evoke very little state anxiety if the learner has the prerequisite skills and abilities needed to perform well on the task. Conversely, a learning task generally regarded by most learners as nonthreatening might be extremely threatening to a low trait-anxious individual because of previous negative experiences. O'Neil and Richardson (1977), therefore suggest that the stressful impact of any instructional situation can be determined only by obtaining actual state anxiety measures in the situation. They further indicate that a number of studies have supported this approach and have shown that measures of state anxiety are more closely related to learning performance and instructional strategies in computer-assisted instruction than are measures of trait anxiety (e.g. Spielberger, O'Neil, & Hansen, 1972).

Anxiety in Instruction

Anxiety is one of the major psychological variables in education (Tobias, 1979). There is a large body of research linking high anxiety to the ability of learners to benefit from various instructional methods. Spielberger (1966) reported a series of experiments initiated in 1955 at Duke University. Spielberger reported that more than 20% of students who were characterized as highly anxious dropped out of school because of academic failure, while only 6% of a low anxious group left school. Sieber et al. (1977) provided a review of the effects of anxiety on learning from instruction in a variety of settings, ranging from traditional lecture-based instruction to computer-based instruction. These researchers documented that anxiety interfered in learner achievement from a variety of the instructional methods studied.

Tobias (1979) reported that in the 1960's and 1970's there was a surge of interest in the educational implications of anxiety research.

Much of the research centered around the treatment of debilitating anxiety. Anxiety reduction programs were increasingly implemented at a variety of educational institutions around the country. Tobias (1979) indicated, however, that very little empirical research concerning these anxiety reduction programs in educational situations were ever reported.

A more recent focus of anxiety research in educational situations has been on the interaction between anxiety and instructional methods. Cronbach and Snow (1977) have suggested that educational psychologists should look more closely at the interaction between learner attributes such as anxiety and instructional methods. To provide directions for future anxiety study, a research model has been proposed by Tobias (1979). The model outlines the effects of anxiety on learning from instruction.

Tobias (1979) described anxiety as an affective state. For anxiety to affect learning, which is a cognitively mediated process, it can affect learning only indirectly by interfering in the cognitive processes. Anxiety can impact on learning during any of the three classical information-processing components: input, processing, and output.

The input process of instruction is the presentation of instructional materials to students. The processing component involves all operations performed by learners to receive, encode, retain, and retrieve instructional input. Output denotes the learner's overt performance on any measurement indicating that instructional objectives have been mastered (Tobias, 1979). Tobias' model suggests that anxiety can affect learning indirectly at three points in the instructional process: preprocessing; during processing; and right after processing and just before output.

Anxiety during the preprocessing stage can affect learning by interfering in the degree to which students receive external stimulation. Anxious students often divide their attention between the instructional task and negative internal feelings. Tobias suggested for this reason, low anxious students tend to outperform their more anxious counterparts due to increased time on-task. Anxiety at this stage is most debilitating since this interference reduces the proportion of instructional content available for processing. Tobias (1979) suggested that any procedures designed to permit students to reexamine instructional input may reduce the interference of anxiety at this stage. Possible instructional strategies may include rewinding videotape or branching back to prior segments in CAI.

Anxiety experienced during cognitive processing affects operations performed to process instructional input. Tobias cited three types of manipulations of instructional content which may have desirable effects on learning outcomes by reducing processing interference from anxiety. First, performance of highly anxious learners is poorer than that of low anxious students on difficult content. Reduction in content difficulty would prove to be effective for anxious students. Second, instructional methods that require students to rely on short-term or intermediate-term memory are subject to greater interference for anxious students than content retrieved from long-term memory. Tobias indicated that any procedures that reduce the degree to which learners have to rely on shorter-term memory will improve achievement of anxious learners. Third, material that is well organized results in superior achievement for anxious students compared to less anxious students. Any organization of input, therefore, will help improve processing of information.

The third stage of Tobias' model is the postprocessing effect. Anxiety can interfere in retrieving content mastered during instruction at an earlier point in time. Postprocessing interference often manifests itself in the form of text anxiety. Students may have progressed through lesson content with seemingly little difficulty yet may "freeze up" in testing situations.

Tobias (1979) cited two studies that have followed the guidelines of the model and have produced results consistent with expectations. Oosthoek and Ackers (1973) reported that the performance of anxious students who could replay an audiotape was significantly improved when compared to those without the replay capability. In addition they found that anxious students tended to utilize the replay option more frequently than low anxious learners.

In a second supportive study, Mayer (1976b) examined the effects of student and experimenter pacing. In the self-paced condition students had control over switching from one problem to the next at any time. In the experimenter-paced condition order of presentation was determined in advance. Mayer reported that self-pacing improved the performance of high anxious subjects but had little effect on low anxious individuals.

Anxiety and CAI

The effects of anxiety on computer-assisted instruction has been the subject of a number of empirical investigations (Sieber et al., 1977). Efforts to alleviate anxiety that inhibits performance from computer-based instruction have largely failed (Clark, 1984). It is now generally agreed that instructional anxiety may have to be circumvented rather than cured. Highly anxious students tend to learn less and drop out of computer-based instruction more frequently than those experiencing only mild anxiety. Therefore, elements in CAI designs that may reduce anxiety would have both positive affective and cognitive implications (Clark, 1984). Reviewed below is research seeking to determine the relationship between state anxiety and performance from CAI in general and in learner controlled CAI.

The Effects of State Anxiety on Performance in CAI

O'Neil, Spielberger, and Hansen (1969) investigated the relationship between state anxiety and performance for male and female college students learning both difficult and easy math concepts. They hypothesized that high state anxious subjects would make more errors than low state anxious subjects on the difficult materials and that this relationship would be reversed on the easy material. High state anxious students, defined by a median split, made significantly more errors than did low state anxious students on difficult problems. This relationship was reversed on the easy material but it was not significant. The data support the prediction from anxiety theory that the effects of anxiety on learning depend upon the strengths of correct responses and competing error tendencies. State anxiety appeared to influence performance by activating error tendencies on the more difficult section of the task.

In conducting a similar CAI study O'Neil, Hansen, and Spielberger (1969), utilized a group of 110 males selected on the basis of extreme scores (upper and lower 20%) on the Trait-anxiety scale of the State-Trait-anxiety inventory. Empirical evidence from this study showed little effect of state anxiety on performance on an easy material section while on-the-other-hand subjects high in state anxiety made significantly more errors than did low state anxious subjects on the more difficult material.

O'Neil (1972) also reported that high levels of state anxiety caused significantly more errors in instruction. This CAI study investigated the relationship of state anxiety and performance in which students were given either neutral or negative (stress) feedback regarding performance. The research subjects consisted of females selected on the basis of extreme trait anxiety scores (upper and lower 20%). Performance was evaluated as a function of state anxiety measured after each problem set. High state anxiety students made more errors than low state anxiety students on all three sections of the learning task (easy, moderate, difficult problems). These findings were significant only for the easy and moderately difficult sections, however. This is in contrast to the findings of the two previous studies. In addition, there was no effect of stress condition on performance. The authors believed that the differences may be attributable to the use of female subjects as compared to males in the previous study.

James and O'Neil (1971) attempted to replicate and extend the previous research by using the same task conditions and procedures as in O'Neil (1972) but employing both male and female students. The subjects were selected on the basis of extreme scores (upper and lower quartiles of normative group) of the trait anxiety scale. For both sexes, the mean number of errors per problem were greater for the high state anxiety group on all three difficulty level tasks. For females, only the difference on the easy problems were significant. For males, only the hard and easy problems were significantly different. There was no difference between high and low state anxiety female students on the most difficult problems, whereas high state anxiety females performed significantly worse on the less difficult problems. Males that were high in state anxiety made more errors than did low state anxiety subjects on the difficult and medium difficult problems. These results do not completely support the proposed hypothesis that high state anxiety levels are debilitating toward learning performance, and especially on difficult learning material.

To positively influence learning of highly anxious students, Leherissey et al. (1971) attempted to improve CAI performance of high state anxiety males by providing memory support. The CAI used difficult problems but supplied experimental subjects with a list of their previous errors as a memory support. The control group did not receive memory support. Students were rank ordered and then divided into high, medium, and low state anxiety groups on the basis of their mean state anxiety scores averaged across difficult, medium and easy problems and randomly assigned to the treatment conditions. High state anxiety students given memory support made fewer errors than did the high state anxiety students without memory support, whereas there was little difference for low and medium state anxiety students. In general, high state anxiety students made significantly more errors than did either medium or low state anxiety students.

Anxiety and Learner Controlled CAI

A number of empirical investigations have examined the effects of learner control on performance and anxiety. Hedl and O'Neil (1977) reported a study by Collier, Poyner, O'Neil, and Judd (1973) that examined the effects of learner control on performance and anxiety. In the study, Collier et al. (1973), examined the effects of learner control of memory support in three concept learning CAI tasks. The studies utilized three treatment conditions which included: (a) no memory-support (no access to previous instructional stimuli), (b) memory-support (received two prior correct instances of a concept), and (c) learner control (students could request memory-support at their discretion). Results indicated that there were no differences between memory support and learner control, however, both were significantly superior to the no-memory-support group. With regard to anxiety, while memory support facilitated performance, it did not reduce state anxiety. State anxiety was reduced only when students had control over the availability of memory support. The authors suggest that this provides evidence that learner control of instructional variables may possess affective benefits.

Using a CAI learning task concerning the identification of edible plants native to Texas, Judd et al. (1975) investigated the effects of learner control of visual materials on state anxiety and performance. The study utilized three treatment groups: (a) no-visual group, (b) visual group, pictures always present, and (c) learner-control group where students had the option to access the pictures at their discretion. The no-visuals group committed significantly more errors on both critical features and identification components of the posttest than the visual group. The performance of the learner control condition did not differ from visual group. The learner control group had similar levels of state anxiety to the visual group. Thus, learner control over visual support did not lead to reductions in anxiety.

Hansen (1972), investigated the effects of learner control of feedback on state anxiety and performance in an imaginary science CAI lesson. Treatment conditions consisted of a no-feedback group who received no information regarding correctness of test-item responses during CAI, a feedback group who always received the words "true" or "false" following a response, plus a statement of the rule following the third test item for each rule and a learner control condition where the students could receive the true-false feedback, view a rule or terminate instruction at their request. Results indicated no significant differences were found with regard to posttest scores for the three groups. With regard to state anxiety, both learner control and the feedback groups showed decreases in state anxiety across the CAI task, whereas the no-feedback group remained relatively higher. Learner control and feedback groups did not differ significantly with regard to state anxiety. The provision of learner control and feedback resulted in greater reductions in state anxiety than no feedback although feedback by itself did not facilitate posttest performance.

In investigating the effects of learner control of module sequence on state anxiety and performance in a computer-managed course Gallagher et al. (1971) found that the learner control group did not differ significantly from the fixed-sequence group with regard to final performance measures. Low trait-anxious students in the learner control condition reported the lowest level of anxiety. Learner control as compared to fixed-sequence condition, did not appear to result in lower levels of state anxiety for the high trait-anxious students. Study results suggest that learner control of course sequence may result in reduction of state anxiety, particularly for low-trait-anxious students. However, the positive effects of learner control did not appear to generalize to the high trait-anxious students.

Summary

There is no doubt that computers are gaining an increased recognition as a valuable educational tool. Computer-assisted instruction constitutes about half of all computer-related activity in schools (Roblyer, 1988). A major advantage of CAI over less interactive forms of mediated instruction is the capability to provide for different learner needs and abilities (Carrier, 1984). Accommodating learner's individual differences is an important concern for teachers and designers of instructional resources such as computer courseware. The computer as an instructional tool offers the courseware designer a plethora of design options for adapting instruction (Hannafin, 1984).

A potential methodology for adapting instruction to individual needs is by providing learners with control over the learning situation. Students may be given control of the lesson pacing, sequence, or other instructional variables. Methods of control have ranged from those where learners have a small role in decision making to highly complex program-controlled adaptive designs that provide advisement based upon diagnosis of student response patterns (e.g. Tennyson & Rothen, 1979). In the learner control design strategies, the underlying principle is that the learner is an adequate judge for selecting the learning strategy that will result in effective learning performance. Advocates of learner control cite benefits of greater individualization and a greater sense of personal responsibility for learning (Hannafin, 1984).

The implementation of learner control of the amount and sequence of instructional information has been a frequent problem in the design of CAI. The research findings concerning the effectiveness of learner control in computer-assisted instruction have been equivocal at best (Steinberg, 1977). This research has consistently shown that when students control CAI they often spend less time on task, terminate instruction too early and fail to use control options effectively (Tennyson, 1980). Learning performance resulting from learner controlled CAI has rarely showed significant improvements when compared to other CAI lesson control strategies (Milheim & Azbell, 1988). Clark (1984) and Carrier (1984) reported that students may profit most from the instructional options they like least, and therefore not utilize lesson control effectively. High performers mistakenly believe that high levels of support are routinely needed during instruction, thus selecting more support than is necessary. Low performers may simply select the path of least resistance through a lesson given their learned failure syndromes.

More recently learner control with various forms of guidance or advisement have greatly improved the success of learners in learner-controlled CAI lessons (Hannafin & Colamaio, 1987; Tennyson, 1980, 1981; Tennyson, Park, & Christensen, 1984). Learners tend to perform most effectively when provided with advisement upon which to base instructional decisions. This is especially true for learners at the lower end of the ability scale and those with little experience in directing their own learning.

While the research indicates that providing learner control of instructional decision making has often proved to be ineffective, Snow (1980) contends that the reason for the less than favorable conclusions of learner control research is due to our lack of empirical knowledge of what type of learners should be granted control and under what conditions. Several learner attributes have been found to have profound effects on learner control of CAI. Tobias (1979) suggested that anxiety is one of the major psychological variables affecting performance and learning from a variety of instructional methodologies. Tobias also suggested that there is a large amount of empirical evidence linking high anxiety to the ability of students to benefit from instruction (Tobias, 1979). In studying anxiety in relation to learning situations, Spielberger (1966) differentiated between anxiety as a transitory state and anxiety as a relatively stable personality trait. Anxiety as a state reaction is of most concern to educational researchers. To measure the construct of state-trait anxiety, Spielberger et al. (1970) developed the State-Trait Anxiety Inventory that enabled researchers to measure anxiety and study its relationship to other instructional variables.

Clark (1984) has indicated that efforts to reduce the debilitating effects of anxiety in learning from CAI instruction has had poor results. Therefore, Clark suggested that instructional anxiety may have to be circumvented rather than cured. A possible method of circumventing learner anxiety may be to incorporate design elements in CAI that would reduce the anxiety level of learners. A number of researchers have sought to identify various CAI design elements that may positively impact anxiety and ultimately the learning of anxious students (Collier et al., 1973; Hansen, 1972; James and O'Neil, 1971; Leherissey et al., 1971; O'Neil, 1972; O'Neil, Hansen, & Spielberger, 1969; O'Neil, Spielberger, & Hansen, 1969). In general this research indicated that high anxiety was debilitating toward learning especially with difficult content. A number of variables which included providing memory support, feedback, and learner control of instructional options were found to positively affect anxiety and learning performance.

From the research it becomes clear, to realize the full potential of the computer and CAI in educational environments the development of high quality instructional courseware is paramount. Computer-assisted instruction courseware should provide students with a positive learning experience that is adapted to their individual learning needs. A number of the CAI instructional design strategies discussed have shown promise in a wide range of empirical investigations and may ultimately provide courseware designers and developers with effective methodologies for producing high quality courseware.

CHAPTER 3
METHODOLOGY

The purpose of this study was to examine the effects of three CAI locus of instructional control strategies on learner performance and anxiety. To carry out the study the following experimental methods and procedures were utilized. To present the methods and procedures used in this study, chapter 3 is divided into the following seven sections: (a) Subject selection; (b) Instrumentation (State anxiety scale, pretest measurement and posttest measurement;) (c) Instructional content; (d) Computer-assisted instructional treatments (program controlled CAI, learner controlled CAI and learner controlled with advisement CAI); (e) Procedures (courseware design, pilot study, study setting, state anxiety scale assessment, pretest procedures, posttest procedures); (f) Experimental design; and (g) Data analysis.

Subject Selection

Study subjects were 106 students from the Department of Health Science Education undergraduate Personal and Family Health course at the University of Florida. Students in these classes are representative of the general University of Florida undergraduate population. Subjects were given extra credit for participation. This contingency was included to stimulate an actual classroom-related incentive missing from most learner-control studies (Tennyson & Buttrey, 1980). Subjects were randomly assigned to one of the three treatment conditions. A general outline of the purpose of the study, time required, assessment procedures and a verbal consent script was presented to participants before they were asked to consent to participation. Approval for the use of human subjects in this study was granted from the University of Florida Institutional Review Board.

Instrumentation

State Anxiety Scale

The State-Trait Personality Inventory (STPI) was used to assess experimental subject's perceived level of anxiety prior to, during and after the CAI learning task. The anxiety measurement provides evidence as to the effect the CAI instructional treatments have on state anxiety. Because it was necessary to obtain repeated measures of state anxiety during the computer-assisted learning task, a 10-item state anxiety (S-Anxiety) subscale of the STPI was used. This briefer subscale interfered less with performance on an experimental task while still providing a valid measure of S-Anxiety (Spielberger, 1979).

The S-Anxiety subscale portion of the STPI is derived from the original State-Trait Anxiety Inventory (STAI). The STPI in addition to providing state and trait measures of anxiety, also contains subscales established to measure state and trait levels of curiosity and anger. Subjects taking the S-Anxiety subscale of the STPI respond in terms of how they feel at the present moment by rating themselves on the the following four-point scale: (a) Not at all; (b) Somewhat; (c) Moderately so; and (d) Very much so. Some of the STPI items (e.g. "I feel nervous," "I feel frightened") are worded so that a rating of (4) indicates a high level of state anxiety (Ax+). Other items (e.g. "I feel calm," "I feel steady") are worded so that a high rating indicates the absence of anxiety (Ax-). The scoring weights for items that indicate presence of high levels of state anxiety are the same as those circled (e.g. Very much so = 4 points, Not at all = 1 point). For items where the high ratings indicated the absence of state anxiety, the scoring weights are reversed. A rating of 4 indicates the presence of high levels of state anxiety while a rating of 1 indicates little state anxiety. To obtain the S-Anxiety measurement, the weighted scores of the 10 items are summed. The range of possible scores for the subscale can range from 10 to a maximum of 40.

In researching the STPI S-Anxiety subscale, Spielberger (1979) reported that in a sample of 199 college students (66 males and 133 females) the mean scores were 17.95 for males and 19.06 for females. For the same subjects, the STPI S-Anxiety subscale was found to have correlations of .95 (males and females) with scores on the state measures of the parent STAI (Form X). In addition, Spielberger (1979) reported the means and alpha reliability coefficients for a group of working adults 18-22 years old, where the means for females (N=180) and males (N=112) were 18.42 and 18.80 respectively. The alpha reliability coefficients were 0.93 for females and 0.91 for males.

As previously noted the STPI S-Anxiety subscale has a high correlation (.95) with STAI (Form X) state anxiety measurement. The STAI (Form X) has high internal consistency. The alpha reliability coefficients for the S-Anxiety measure for college age males (N = 296) and females (N = 481) were reported as being 0.91 for males and 0.93

for females (Spielberger 1983). In addition, Spielberger reported evidence of construct validity of the STAI S-Anxiety scale through contrasted groups. Mean S-Anxiety scores for stressful male (N = 1893) and female (N = 71) military recruits were 44.05 and 47.01 respectively, while scores for non-stressed male (N = 296) and females (N = 481) college students were 36.47 and 38.76 respectively. Additional evidence reported by Spielberger of the STAI S-Anxiety scales construct validity includes two studies. In the first study where the STAI S-Anxiety inventory was given under high (exam) and low-stress (normal) conditions to undergraduate college subjects (N = 900), the mean S-Anxiety scores were substantially higher in the exam condition (males = 54,99 and females = 60.51) than in the normal condition (males = 40.02 and females = 39.36). In the second study, utilizing 197 undergraduate students, S-Anxiety levels were assessed during a relaxed, a normal, an exam and a stressful movie condition. Mean scores for males were 32.70, 36.99, 43.01, and 50.03 respectively, while the scores for females were 29.60, 37.24, 43.69, and 60.94 respectively. The S-Anxiety scores were similar with the exception of the stressful movie condition that seemed to be more upsetting for the females.

The original STAI (Form X) has received extensive review as reported by Spielberger (1983). The STAI has been used extensively in research and clinical practice since its introduction in 1966. A majority of the early studies used the STAI to examine the effects of stress and anxiety on performance and instruction (Spielberger, 1983).

Pretest - Posttest Measurements

The pretest criterion test consisted of 24 randomly ordered multiple-choice questions which tested for learning of factual content as presented in the CAI lesson. Twelve questions embedded in the instructional treatments were included on the pretest. In addition, 12 non-embedded content-related questions were included. The posttest was identical in style to the pretest and consisted of the same 24 items but arranged in a different order. The internal consistency of the posttest measurement was ascertained using the Kuder-Richardson (KR20 = .73) procedure.

Instructional Content of the CAI Lesson

The computer-assisted instructional task selected for this study was an instructional program that introduced information and assisted students in developing an awareness of alcohol and its effects on behavior and the body. The CAI program was divided into four sections: (a) Alcohol the Drug, (b) Effects of Alcohol, (c) Metabolism of Alcohol, and (e) Alcohol Withdrawal. Each lesson section consisted of from eight to ten instructional frames and embedded questions (see APPENDIX A and B). The majority of instructional frames also consisted of multiple layers of textual information that were progressively presented as students proceeded. The lesson content was supplemental to the regular course content. Each of the three CAI treatments consisted of the same basic CAI tutorial program content with modifications of the locus of instructional control as discussed below.

Computer-Assisted Instructional Treatments

Three CAI lesson versions representing different CAI locus of instructional control design strategies were developed for the Macintosh computer. The three lesson control strategies included program control, learner control, and learner control with advisement. System-level flowcharts adapted from Hannafin and Colamaio (1987) that illustrate the different sequence and control options of the three CAI lesson versions are presented in APPENDIX C.

Program Controlled CAI

In the program control version, students followed a predetermined path through the lesson (see APPENDIX C). The lesson proceeded in a linear manner from beginning to end. Students were periodically presented with embedded questions and received response sensitive feedback after answering each embedded question. Feedback indicated whether the students response was correct or incorrect. Instruction proceeded to the next section if their response was correct or branched to a review of the content related to the question if their response was incorrect. After the review the same question was presented a second time. Upon answering the question feedback was again provided, and the lesson continued if the student's response was correct. In the case of a second wrong answer, the correct response was given and the lesson then continued.

Learner Controlled CAI

This lesson control version consisted of learner controlled CAI where learners were given control of lesson sequence, review, number of practice questions, and the decision when to terminate the CAI lesson. The learner control subjects were allowed to make control decisions at points where the program control treatment limited learner options (see APPENDIX C). Students were able to control the lesson sequence by choosing the order of sections to study. Students could also move forward or backward in the lesson sections as well. Students were given the option of answering embedded questions or skipping them to proceed to the next instructional frame. When students answered questions, feedback was provided. If the response was incorrect, the student was given the option of branching back to and reviewing the related content or to proceed to the next section of the lesson. When students chose to review a segment, the option to repeat the question a second time was given. If the student chose not to repeat the question, the lesson continued to the next section. If the question was answered correctly the second time, feedback was given and the lesson proceeded. If the question was answered incorrectly again, the correct response was given and the lesson continued.

Learner Control with Advisement CAI

The learner control with advisement group was presented with the same CAI lesson version as the learner control group except that advisement (coaching) was provided at each decision point in the lesson (see APPENDIX C). At the same decision points as in the learner control condition, students in the learner control with advisement condition were presented with advisement as to the recommended lesson sequence, when to review content, and when to repeat questions. If students attempted to proceed through the lesson in a sequence deemed inappropriate by the designer, advisement appeared suggesting the most appropriate lesson sequence In addition, when learners answered questions incorrectly, advisement appeared suggesting that content be reviewed. If students attempted to leave the lesson before finishing all sections they were advised to complete all content areas before terminating instruction.

Courseware Design and Development

The design and development of the CAI program was in accordance with a systematic design model suggested by Roblyer (1988). The systematic design process included three phases. The first phase, Phase I, was Design. The Design stage included (a) stating instructional objectives, (b) an instructional analysis, (c) developing performance objectives, (d) developing testing strategies, and (e) designing instructional strategies. Phase II, Preprogramming Development included (a) developing flowcharts, (b) developing support material, and (c) review and revision before programming. The final phase, Phase III, was Program Development and Evaluation which included (a) programing first-draft materials and (b) performing a formative evaluation.

In addition to following a systematic design approach as outlined above, a team approach was also utilized in the courseware development process. The team approach described by Roblyer (1988) consists of a team of at least one person of each of the following types: instructional design expert knowledgeable in courseware design and learning theory, content expert who has taught in this area, and a programmer experienced in courseware development. The CAI program was reviewed periodically by an instructional design expert, subject matter expert and instructional computing expert.

The CAI courseware for this study was authored using Apple's HyperCard program. HyperCard has gained recent popularity as a CAI courseware authoring tool due to its ease of use and impressive capabilities. HyperCard was chosen because of its ability to provide an easily learned user interface. The user interface utilized was simple and intuitive requiring virtually no learner training.

With HyperCard, the CAI author creates a stack(s) of individual 5" by 7" instructional frames called "cards." The cards can include both textual and graphic information. Advanced HyperCard applications can also include graphic animation and sound as well. Cards in a HyperCard stack can be "linked" to any other card in the stack via "buttons." The linking and button features provide the capability to branch from one section of the lesson to any other. A HyperCard programming language called HyperTalk allowed very sophisticated control of instructional sequences, monitoring of student activities and instructional variables such as time and number of questions attempted by students. HyperTalk was used in the CAI lesson to provide lesson control options where required.

Pilot Study

A pilot study was conducted to try out the proposed procedures on a group of subjects. The appropriateness and practicality of the data collection instruments were assessed. In addition, the pilot study assisted in determining the adequacy of the research procedures delineated and potential unanticipated problems that may have resulted. The pilot study procedures were conducted in accordance with the methodology and procedures specified for the proposed research study.

Procedure

State Anxiety Scale assessments, pretest measurements, CAI lessons, and posttest measurements were all conducted in the Macintosh Lab, 521 Weil Hall on the University of Florida campus. Subjects were seated individually at a Macintosh II workstation. Each Macintosh II was configured with a color monitor, keyboard, mouse and networked to a printer. There were a total of 16 Macintosh II workstations in the lab. Up to 16 subjects could be accommodated during a CAI session. While students were randomly assigned to treatment groups, they were allowed to sign up for any lab time scheduled, therefore, labs consisted of subjects from different treatment groups. Before starting the CAI lesson, subjects were given an introduction to the Macintosh Lab, the Macintosh II computer and were read the informed consent script. Subjects who agreed to voluntarily participate were then instructed how to use the mouse thereby enabling them to proceed through the HyperCard designed CAI lesson.

State Anxiety Scale Assessments

State anxiety was periodically assessed using the S-Anxiety subscale of the State-Trait Personality Inventory (STPI) developed by

Spielberger (1979). The S-Anxiety subscale of the STPI, consisting of ten items, was administered three times via the Macintosh computer programmed with HyperCard. The session began with an initial assessment of state anxiety level prior to beginning the CAI lesson and the pretest. Students responded to the ten questions by pointing with the mouse to the appropriate response (four possible responses) and then clicking the mouse button to select that response. Upon completing the initial state anxiety measurement, subjects were then branched to the pretest assessment. Subjects were later readministered the STPI state anxiety scale midway through the CAI lesson and then again following administration of the posttest.

Pretest Procedures

Pretest measurements were conducted after the initial state anxiety assessment. The pretest was conducted via the Macintosh Computer programmed by HyperCard. Upon completing the pretest subjects were branched directly to the title frame of the CAI lesson.

Posttest Procedures

The posttest measurement was conducted immediately following the CAI lesson prior to administration of the final state anxiety inventory. Like the pretest, the posttest was also administered using the Macintosh computer programmed with Hypercard.

Experimental Design

A split-plot experimental design was used in this study for the state anxiety measures. The design consisted of three between-treatment levels (program control, learner control, and learner control with advisement) and three within-treatment levels (pre-task, on-task and post-task state anxiety levels). For achievement, a pretest-posttest experimental design was used.

A minimum of thirty subjects per treatment condition were sought to insure an adequate sample size as recommended by Slavin (1984). Subjects randomly assigned to the three treatment conditions were administered the same pretest and posttest measures along with periodic administrations (SA1, SA2, and SA3) of the S-Anxiety subscale of the STPI before, during and after instructional treatments.

Data Analysis

In order to determine the effect of the three treatment conditions (program controlled CAI, learner controlled CAI and learner control with advisement CAI) on anxiety and learning performance, the following statistical analyses were conducted:

1. A one-way ANOVA was used to compare pretest scores between the program control, learner control and the learner control with advisement treatment conditions to ascertain any possible pre-existing achievement group differences.
2. A split-plot ANOVA was used to determine whether state anxiety changes across measurement occasions differ by program control, learner control and the learner control with advisement treatment conditions (Hypothesis 1).
3. A regression analysis was used to test the relationship between posttest achievement and:

   a. pretest scores (Hypothesis 2).
   b. on-task anxiety levels (Hypothesis 3).
   c. treatments (program control, learner control and learner control with advisement groups) (Hypothesis 4).
   d. gender (Hypothesis 5).
   e. treatment (program control, learner control and learner control with advisement groups) by pretest interaction (Hypothesis 6).
   f. treatment (program control, learner control and learner control with advisement groups) by anxiety interaction (Hypothesis 7).

4. A one-way ANOVA was used to compare the time to lesson completion of the program control, learner control and the learner control with advisement treatment conditions (Hypothesis 8).

Summary

The methodology as presented in this chapter was designed to examine the effects of three CAI locus of instructional control strategies on learner performance and state anxiety. Chapters 4 and 5 present the results of the study procedures, a discussion of the results, implications, and recommendations for further study.

CHAPTER 4
RESULTS AND DATA ANALYSIS

The purpose of this investigation was to examine the effects of three CAI locus of instructional control strategies on learner performance and anxiety. Three CAI lessons representing program controlled, learner controlled and learner controlled with advisement locus of instructional control strategies were utilized to determine their effect on learning and state anxiety levels measured during the instructional task. To test the hypotheses stated in Chapter 1 a split-plot experimental design was used to examine state anxiety measures. To compare student achievement resulting from the three CAI designs a pretest-posttest experimental design was used. This chapter presents the results of the data analysis.

Study Subjects

Subjects who participated in this research study consisted of 106 (N = 37 males and N = 69 females) volunteer undergraduate level University of Florida students. All subjects who participated were enrolled in a general humanities elective course entitled Personal and Family Health. For the 106 study subjects, 65 reported having what they felt was little or no previous computer experience, 39 indicated that they had had moderate computer experience and only 2 subjects indicated that they had had extensive computer experience. In order to assure no existing group differences in achievement levels of subjects randomly assigned to treatment groups, an ANOVA procedure was utilized to compare group pretest scores. An analysis of variance indicated no significant difference, F(2,103) = 1.51, p> .05, for pretest scores of the three treatment conditions (program control, learner control, and learner control with advisement). Pretest and posttest scores for treatment conditions are presented in Table 3-1.

TABLE 3-1
Means and Standard Deviations for Pretest and Posttest Scores by Treatment Condition

Control Strategy		Pretest	Posttest
Program Control	Mean	8.38	18.94
(N=37)	SD	(2.02)	(3.21)
Learner Control	Mean	8.92	17.97
(N=37)	SD	(2.23)	(3.57)
Learner Control	Mean	8.06	18.66
Advisement	SD	(1.98)	(3.57)
(N=32)			

Results

The results of the research study are presented on a hypothesis by hypothesis basis:

Hypothesis 1: There is no significant interaction between experimental treatments (program control, learner control and learner control with advisement groups) and occasion (pretask, on-task and post-task) for state anxiety levels.

To test Hypothesis 1, a split-plot analysis of variance with three between-group levels (program control, learner control, and learner control with advisement) and three within-subject levels (pretask, on-task and post-task state anxiety levels) was conducted. Means and standard deviations for the group-treatment factor and within-subject factor are presented in Table 3-2.

TABLE 3-2

Means and Standard Deviations for State Anxiety Measurement Occasions by Treatment Condition

Control Strategy		SA1	SA2	SA3
Program Control	Mean	18.05	16.38	15.84
(N=37)	SD	(5.00)	(4.90)	(5.32)
Learner Control	Mean	16.67	15.65	15.35
(N=37)	SD	(5.20)	(5.73)	(5.27)
Learner Control	Mean	16.12	16.41	15.19
Advisement	SD	(4.58)	(4.98)	(5.10)
(N=32)				

Notes: SA1 = State Anxiety Measurement 1 (pre-task); SA2 = State Anxiety Measurement 2 (on-task); SA3 = State Anxiety Measurement 3 (post-task).

The split-plot analysis of variance of state anxiety change across measurement occasion for treatment conditions, shown in Table 3-3, demonstrates that there was no significant difference for the main effect of treatment, F(2,103) = 0.40, p> .05. The two-way interaction: Occasion by Treatment was also not significant, F(4,206) = 1.46, p> .05. There was a significant main effect for the within-subject variable of measurement occasion, F(2,206) = 9.17, p< .05.

TABLE 3-3

Source Table of ANOVA of State Anxiety Change Across Measurement Occasions for Treatment Conditions

Source	SS	df	MS	F
Between Treatments				
Treatments	53.23	2	26.62	0.40
Error	6847.29	103	66.48	
Within Treatments				
Occasion	117.80	2	58.90	9.17*
Occasion X Treatment	37.64	4	9.41	1.46
Error (occasion)	1323.40	206	6.42	

*p< .05 with Geisser-Greenhouse correction

The data does not support the rejection of Hypothesis 1 concerning the interaction of treatment and measurement occasion for state anxiety levels. However, the analysis indicated that there was a significant difference in state anxiety levels across measurement occasions for the treatment groups combined (Figure 3-1). Specifically, this significant within-subject difference in state anxiety levels across measurement occasions reflects a general reduction of subjects' perceived level of state anxiety as the CAI lesson proceeded.

Hypotheses 2 through 7 were tested using a multiple linear regression model to test the relationship between posttest achievement and pretest performance, on-task state anxiety level (SA2), treatment, gender, and the two-way interactions of treatment by pretest and treatment by on-task anxiety.

Hypothesis 2: There is no significant relationship between pretest scores and posttest achievement.

As indicated by Table 3-4, the regression analysis yielded a significant relationship, F(1,96) = 6.93, $p < .05$, between pretest scores and posttest scores following the CAI treatments. Therefore, this null hypothesis was rejected. Pretest scores are a reliable predictor of posttest performance by study subjects.

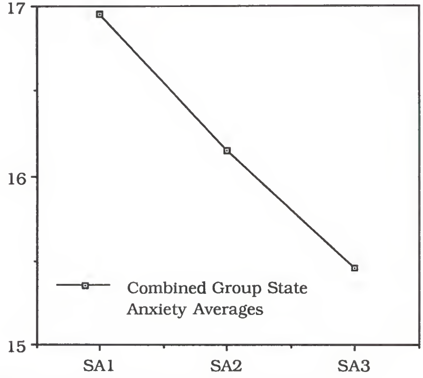


Figure 3-1. State Anxiety Means of Treatment Groups

Hypothesis 3: There is no significant relationship between on-task anxiety and posttest achievement.

The computed F ratio for the relationship between on-task anxiety (SA2) and posttest achievement was F(1,96) = 1.37 (Table 3-4). Because the F ratio was not significant at the .05 level, this hypothesis was not rejected.

Hypothesis 4: There is no significant relationship between CAI instructional treatments (program control, learner control and learner control with advisement groups) and posttest achievement.

The analysis of the relationship between treatment and posttest achievement resulted in an F ratio of F(2,96) = 0.24 (Table 3-4). The means for the treatment posttest scores are presented in Table 3-1. Because this F ratio was not significant at the .05 level, the null hypothesis was not rejected.

Hypothesis 5: There is no significant relationship between gender of the subjects and posttest achievement.

The F ratio for the relationship between gender and posttest achievement was F(1,96) = 0.13 (Table 3-4). This F ratio was not significant at the .05 level. Therefore, the null hypothesis could not be rejected.

Hypothesis 6: There is no significant relationship between the interaction of CAI instructional treatments (program control, learner control and learner control with advisement groups) and pretest scores on posttest achievement.

TABLE 3-4

Linear Regression to Test the Relationship Between Independent Variables and Posttest Performance

Source	Type III SS	df	MS	F
Pretest	76.55	1		6.93*
SA2	15.17	1		1.37
Treatment	5.22	2		0.24
Gender	1.43	1		0.13
Pretest X Treatment	1.99	2		0.09
SA2 X Treatment	37.22	2		1.69
Error	1060.31	96	11.04	

*p< .01 Note: The overall test of significance was F = 1.85 with df = 9,96.

The computed F ratio for the relationship between interaction of treatment and pretest score on posttest achievement was F(2,96) = 0.09 (Table 3-4). This F ratio was not significant at the .05 level and therefore, did not allow rejection of the null hypothesis.

> Hypothesis 7: There is no significant relationship between the interaction of CAI instructional treatments (program control, learner control and learner control with advisement groups) and on-task state anxiety levels on posttest achievement.

The relationship between the interaction of treatment and on-task state anxiety level (SA2) on posttest achievement resulted in a computed F ratio of F(2,96) = 1.69 (Table 3-4).

Because this F ratio was not significant at the .05 level, this hypothesis was not rejected.

To test Hypothesis 8, a one-way analysis of variance was conducted on the data. Means and standard deviations for the time required for each treatment to complete the CAI lessons are presented in Table 3-5.

TABLE 3-5

Means and Standard Deviations for Time to Lesson Completion by Treatment Condition

Control Strategy		Time (in minutes)
Program Control	Mean	26.88
(N=37)	SD	(6.48)
Learner Control	Mean	23.75
(N=37)	SD	(6.97)
Learner Control	Mean	28.37
Advisement	SD	(6.26)
(N=32)		

> Hypothesis 8: There is no significant difference in time to lesson completion between the program control, learner control and the learner control with advisement groups.

The ANOVA yielded a significant main effect, $F(2,103) = 4.48$, $p < .05$, for the between treatment factor (Table 3-6). A post hoc analysis of the effect using the Tukey HSD procedure indicated that a significant difference existed between the learner control with advisement treatment condition and the learner control condition with regard to time required to complete the CAI lesson. The learner control group used a significantly less amount of time to complete the CAI lesson. The time required by the program control group was not significantly different than the other two groups.

TABLE 3-6
ANOVA of Time to Lesson Completion by Treatment Condition

Source	SS	df	MS	F
Between Treatments	389.74	2	194.87	4.48*
Within	4475.38	103	43.45	

$p < .05$

Summary

The results of the data analysis indicated several statistically significant effects. First, there was a significant decrease in state anxiety levels of subjects across measurement occasions. Second, a linear regression analysis revealed that a significant relationship existed between a learner's pretest scores and their posttest performance. Finally, the time required to complete the CAI lesson was significantly greater for the learner control with advisement group than the time required by the learner control group.

CHAPTER 5
CONCLUSIONS AND RECOMMENDATIONS

The purpose of this study was to examine the effects of three CAI locus of instructional control strategies on learning and learner state anxiety levels. Three CAI lessons representing program controlled, learner controlled and learner controlled with advisement locus of instructional control strategies were utilized to determine their effect on learning and state anxiety levels measured during the instructional task.

The study design consisted of a split-plot experimental design to investigate state anxiety levels. For achievement, a pretest-posttest experimental design was used. A total of 106 University of Florida undergraduate students participated in the study. Study subjects were randomly assign to treatment groups (program control, learner control, and learner control with advisement). All subjects completed the CAI lesson on the Macintosh II computer. The CAI lesson for all subjects consisted of the same instructional content with modifications in the locus of instructional control provided to learners. Students in the program control treatment were presented with a predesigned fixed sequence lesson. No lesson control was granted. The learner control treatment was given control over the instructional variables of lesson sequence, number of practice questions, review of content related to questions, and lesson termination. The learner control with advisement group had control over the same instructional variables as the learner control group and in addition, was given advice (coaching) concerning the recommended learning strategy to be utilized at each decision point in the lesson. State anxiety levels were measured on three occasions during the CAI lesson.

Findings

The following hypotheses stated in the operational null form were analyzed using a split-plot analysis of variance, multiple linear regression, and one-way analysis of variance procedures.

> Hypothesis 1: There is no significant interaction between experimental treatments (program control, learner control and learner control with advisement groups) and occasion (pretask, on-task and post-task) for state anxiety levels.

The null hypothesis was not rejected. There was however, a significant decrease in subjects' state anxiety levels across measurement occasions that was the same across treatments.

> Hypothesis 2: There is no significant relationship between pretest scores and posttest achievement.

This null hypothesis was rejected.

> Hypothesis 3: There is no significant relationship between on-task anxiety and posttest achievement.

This null hypothesis was not rejected.

> Hypothesis 4: There is no significant relationship between CAI instructional treatments (program control, learner

control and learner control with advisement groups) and posttest achievement.

This null hypothesis was not rejected.

Hypothesis 5: There is no significant relationship between gender of the subjects and posttest achievement.

This null hypothesis was not rejected.

Hypothesis 6: There is no significant relationship between the interaction of CAI instructional treatments (program control, learner control and learner control with advisement groups) and pretest scores on posttest achievement.

This null hypothesis was not rejected.

Hypothesis 7: There is no significant relationship between the interaction of CAI instructional treatments (program control, learner control and learner control with advisement groups) and on-task state anxiety levels on posttest achievement.

This null hypothesis was not rejected.

Hypothesis 8: There is no significant difference in time to lesson completion between the program control, learner control and the learner control with advisement groups.

This null hypothesis was rejected.

Discussion

CAI and State Anxiety

The data analysis indicated that there was no significant treatment effect on student state anxiety levels across pre-task, on-task and post-task measurement occasions. Study subjects' state anxiety levels were unaffected by the locus of instructional control strategy used in the design of their respective instructional treatments. Providing learners with control or control with advisement over the instructional variables of lesson sequence, number of practice questions to answer, review of content related to questions answered incorrectly, and the decision when to terminate the CAI lesson had no significant impact on learner anxiety levels when compared to a program controlled CAI design. It has been suggested that the more control a student has over a learning task, the better will be their performance and as control over learning material increases anxiety levels would decrease (Sieber et al., 1977). Three earlier CAI studies have previously reported that providing learners with control of instructional variables did result in decreases in state anxiety levels (Collier et al., 1973; Gallagher et al., 1971; Hansen, 1972). However, these decreases in state anxiety were not significantly lower than similar treatments where learner control was not provided. Gallagher et al. (1971) who examined learner control of module sequence on state anxiety and performance, reported that learner control of course sequence resulted in reduced state anxiety levels for only those subjects who were low in trait-anxiety. Though trait anxiety was not assessed in this study, the program control, learner control and learner control with advisement treatment conditions had no different significant effect on state anxiety levels regardless of trait anxiety levels.

There was a significant within subjects effect for measurement occasion of state anxiety levels. State anxiety levels significantly decreased across measurement occasions for the treatment groups. The combined means for the three treatment groups for the three measurement occasions were 16.95 for SA1, 16.15 for SA2, and 15.46 for SA3. Several possible explanations may have accounted for this decrease in state anxiety levels. First, all learners, when exposed to a new, unfamiliar and potentially threatening learning experience can be expected to initially exhibit high state anxiety levels in response to the situation. As learners become familiar and more comfortable with a new learning situation, they usually overcome their initial state anxiety reaction. In this study, as the learners proceeded through the CAI program they may have realized that the instructional task was indeed nonthreatening.

A second reason may have been that many individuals perceive any sort of technology as potentially threatening. The emergence of computers in education has led to concerns, both cognitively and emotionally based, about the response of learners to the new technology (Cambre & Cook, 1985). Computer anxiety has been conceptually defined as "the mixture of fear, apprehension, and hope that people feel when planning to interact or when actually interacting with a computer (Rohner & Simonson, 1981, p. 551)." Since a majority of subjects in this study (61%) indicated that they had little or no computer experience, it could be expected that they would react with initially high levels of state anxiety. The Macintosh computer and HyperCard with its intuitive and easily learned user interface may have effectively led to decreases in learner state anxiety levels as the CAI progressed. Students completing the CAI programs were required to simply use the mouse to point and click on buttons to make learning choices or navigate through the lesson. In general, the CAI treatments resulted in no negative effects on learner anxiety levels or attitude. Upon completing the CAI lesson, students were asked to rate their attitude (negative, neutral, or positive) toward the CAI lesson. Results of the attitude survey indicated that 86% of all study subjects responded positively to the CAI learning experience, 14% indicated that their feelings were neutral, while no one responded negatively toward the CAI lesson. These findings were also similar when the treatment groups were compared.

There was no interaction between CAI locus of instructional control strategy and occasion for measurement of state anxiety levels. The locus of instructional control design strategy appears to have no significant interactive effect with occasion of measurement (pre-task, on-task and post-task) on learner anxiety levels. The state anxiety measurements of study subjects indicated a similar gradual reduction of state anxiety for all treatment groups across the CAI lesson (Program Control - SA1 = 18.05, SA2 = 16.38, SA3 = 15.84; Learner Control - SA1 = 16.67, SA2 = 15.65, SA3 = 15.35; and Learner Control with Advisement - SA1 = 16.12, SA2 = 16.41, SA3 = 15.19). A number of researchers have theorized and tested the hypothesis that providing learners with control over certain instructional variables would enhance learning and reduce anxiety levels (Collier et al., 1973; Gallagher et al., 1971; Hansen, 1972; Judd et al., 1973). This study supported the results of Hansen (1972) and Judd et al. (1975) in finding that learner control (or the learner control with advisement) had no effect on state anxiety levels in instructional situations beyond the effects caused by an imposed control (program control) condition.

In addition, the program control condition did not have any undue effects on state anxiety levels when compared to the learner control strategies. The program control condition did not create higher anxiety levels that may have indicated that learners felt constrained or overly directed by the imposed control.

Pretest

The results of the multiple linear regression analysis indicated that there was a significant relationship between study subject's pretest scores and their posttest scores following the CAI treatment. For the CAI lesson, a learners' pretest score appears to be a reliable predictor of his performance on the posttest measurement.

State Anxiety Levels During CAI

The regression analysis indicated that there was no significant relationship between subjects' on-task (SA2) state anxiety levels and their posttest performance. In the present study, subjects who were high in state anxiety and subjects who were low in state anxiety did not differ with regard to posttest achievement resulting from the CAI treatments. Tobias (1979) has suggested that high anxiety can be debilitating in instructional situations. According to Tobias, anxiety, which is an affective state, interferes with the cognitive processes of learning. It would be expected then that highly anxious study subjects would have lower posttest scores due to the negative effects of state anxiety. Likewise, low anxiety students might be expected to have higher posttest scores due to the lack of the debilitating effects anxiety may impose. This was not the case however.

The design of the CAI programs (program control, learner control and learner control with advisement) may have been an important factor in assuring that anxiety had a minimal impact on learning. A number of recommendations were followed from Tobias' (1979) model which provides instructional researchers with guidelines for designing instruction to minimize anxiety in instructional situations. The recommendations that may have impacted anxiety during this investigation of CAI learning may have included the provision of immediate practice of instructional content, remediation, well organized content, and providing students with the ability to reexamine instructional input (available only for learner control and learner control with advisement groups). Providing these instructional features may have minimized any influence that anxiety may have had during the learning task.

CAI Locus of Instructional Control Strategies

The data analysis indicated that there was no significant relationship between CAI treatment group and posttest achievement. The mean posttest scores were 18.94 for the program control, 17.97 for the learner control and 18.66 for the learner control with advisement treatment group. Students from the three treatment conditions performed equally as well on the posttest measure of achievement. Therefore, the learner control or learner control with advisement treatment conditions possessed no inherently superior instructional characteristics that affected learning over an imposed program control design strategy. While there was no significant posttest achievement difference between the three locus of instructional control strategy treatments, subjects of the three treatment groups did answer an average of 77% of the posttest questions correctly.

An extensive body of research has provided conflicting reports of the viability of learner control as an effective instructional design methodology. The learner controlled design methodology has been applied to traditional instructional methods, programmed instruction and more recently computer-based instruction. In learner controlled instruction designers typically place certain instructional variables under the control of learners. These instructional variables have included lesson sequence, feedback, depth of study, and numerous other variables as well. Several researchers who have reviewed the learner controlled research have indicated that learner control strategies do not result in any drop in learning, yet there was no clear indication that the overall use of learner control caused any increase in student achievement, efficiency, or attitude toward instruction (Merrill, 1980; Milheim & Azbell, 1988; Steinberg, 1977). This research study is supportive of these conclusions that learner control possesses no advantage over imposed control instruction.

Clark (1984) and Carrier (1984) suggested that learners may not be sophisticated enough to effectively direct their own learning strategies when provided control over instructional variables. Hannafin (1984) suggested that providing learner advisement during the instructional task would assist students in utilizing the learner control features more effectively. Support for Hannafin's recommendations are found in several studies by Johansen and Tennyson, (1983), Laurillard, (1984), Tennyson, (1980), and

Tennyson, (1981). The results of this research study however, do not support the recommendations made by Hannafin (1984). In the present study, the advisement provided to learners in the learner control with advisement group did not result in any greater achievement on the posttest when compared to posttest achievement of the learner control group which did not receive advisement. The addition of the advisement to the learner control strategy actually increased the instructional time utilized by the learner control with advisement group, yet there was no associated learning gain.

Gender

In this study it was determined that there was no significant relationship between a subjects gender and their posttest performance. Females did equally as well as males on the posttest measurement. The computer experience level for males and females appeared to be quite different yet did not affect learning performance. The computer experience level of males was considerably higher than for females. Before the computer lesson, students were asked to indicate their self-perceived computer experience level (a. little or no computer experience; b. moderate computer experience; or c. extensive computer experience). About 46% of males compared to 70% of females indicated that they possessed little or no computer experience. About 51% of males reported having moderate computer experience while only 28% of females reported the same experience level. Only 3% of males indicated they had extensive computer experience compared to less than 2% for females.

With this large disparity between computer experience levels of males and females one might expect some effect on learning. Despite the fact that males were considerably more experienced with computers, this did not ultimately impact learning. As mentioned previously, the Macintosh computer and HyperCard provide a very intuitive and easily learned user interface requiring minimal prerequisite computer skills and knowledge by learners. The user-friendly nature of the CAI design most likely caused the learner variables of gender and computer experience level to become irrelevant.

Achievement and CAI Locus of Instructional Control

In this study there was no significant relationship between the interaction of CAI instructional treatments and pretest scores on posttest achievement. Learners who scored low on the pretest or learners who scored high on the pretest did not benefit differentially from the three treatment conditions. Neither of the three conditions seemed to provide any added advantage or disadvantage to learners of differing ability levels (as measured by the pretest).

Gay (1986) investigated the interaction of learner control of lesson pace, sequence, presentation mode, practice and depth of study with prior conceptual understanding in a computer-assisted interactive video lesson. In contrast to the present study, Gay found that low aptitude subjects in the learner control group had significantly lower posttest scores than the low aptitude subjects in a program control group and lower posttest scores than high aptitude subjects in a learner control and a program control group.

State Anxiety and CAI Locus of Instructional Control

There was no significant relationship between the interaction of treatment and on-task state anxiety levels on posttest achievement. No treatment condition served to provide learners, with varying levels of anxiety, with a more efficacious lesson design strategy for affecting posttest achievement. State anxiety levels may therefore not be an important consideration when designing CAI courseware that will utilize various locus of instructional control methodologies.

Time

The results of this study indicate that there was a significant difference between treatment groups in the time required to complete the CAI learning task. The mean times for lesson completion were 26.88 minutes for the program control group, 23.75 minutes for the learner control group and 28.37 minutes for the learner control with advisement group. A post hoc analysis revealed that the learner control group required significantly less time to complete the CAI lesson than required by the learner control with advisement group. This was the only significant difference among the three groups with regard to time.

While the learner control with advisement group utilized 4.62 minutes more than the learn control group, there was no significant relationship between CAI treatment and posttest achievement as discussed previously. This indicates that the extra 4.62 minutes used by the learner control with advisement group was basically wasted time. The extra time did not result in any additional learning. This finding is similar to the study by Goetzfried and Hannafin (1985) who also found no achievement gains resulting from increased learning time required by learner control with advisement group. This is a very critical issue when dealing with valuable instructional time and in designing CAI courseware.

A number of researchers have indicated that in general, learners do not possess the ability to efficaciously manage their learning when given control over certain instructional variables (Carrier, 1984; Clark, 1984; Merrill, 1980). Other researchers have suggested that achievement from learner controlled CAI can be significantly enhanced when some form of advisement or coaching is provided to learners to guide their learning decisions (Hannafin, 1984; Ross 1984; Tennyson & Buttrey, 1980). The results of this study indicated that students in the learner control condition seemed to be a good judge of when to answer embedded questions and when to review the content related to the questions in the case of a wrong answer. Students in the learner control condition answered an average of 20.9 questions while the learner control with advisement group answered an average of 30.9 questions (students in the program control condition answered all 29 embedded questions). Answering more questions did not lead to a treatment effect on posttest achievement.

The learner control with advisement treatment received continual advisement suggesting proper lesson sequence, when to answer embedded questions and when to review content. The advisement consisted of reminders about proper lesson sequenced to be followed, messages suggesting that students answer questions to help attain section objectives, and to review content related to embedded questions that were answered incorrectly. The subjects of this treatment apparently may have reacted to the advisement by following it when indeed it may have not been in their best interest to do so. It appears that the type of advisement and in what situations advisement should be followed or ignored is critical.

Implications

The results of this study provide several important implications for educational researchers and CAI courseware designers. The three locus of instructional control strategies implemented in this research study did not have any differential effect on learning. The posttest achievement of the program control, learner control and learner control with advisement treatment groups were all equivalent. Therefore, the issue of whether to incorporate instructional control options in CAI courseware designs may not be as critical as previously believed. This study does suggest that well planned systematically designed courseware which utilizes state of the art instructional technology can be effective when certain guidelines are followed (Roblyer, 1988). In this study, all three CAI treatments consisted of well organized instruction, individual student pacing of the lesson, embedded practice questions, immediate feedback, and opportunities for remediation. Computer-assisted instruction designers should be aware that using a systematic approach utilizing a model such as the one presented by Roblyer (1988) may be more important than locus of instructional control considerations in the design of CAI.

The state anxiety levels of undergraduate students in this study did not have an affect on their learning from the CAI lesson treatments. The data analysis revealed no interaction between state anxiety levels and treatment. Because state anxiety levels and the CAI lesson treatments did not interact to affect learning performance, state anxiety does not appear to be an important consideration when assigning students to the three CAI locus of instructional control strategies. The study did indicate that as the CAI lesson treatments progressed, student anxiety levels for all treatments declined. This decline may have been due to an initial state anxiety response by learners when beginning the computer lesson. This is a natural response to all new and potentially threatening situations. As the learners became more comfortable with the new instructional task and the computer technology, anxiety levels gradually declined. The Macintosh and the HyperCard courseware authoring program provided a very user-friendly interface that most likely played an important role in reducing students state anxiety levels.

In addition, the instructional CAI treatments did not have a differential effect upon state anxiety levels. Students of one treatment did not exhibit or react with higher state anxiety levels than did students of the other treatments. It has been previously indicated that students in an imposed program controlled CAI lesson may react with high state anxiety levels that would in turn interfere in learning (Sieber et al., 1977). These students may feel constrained or overly controlled thereby producing high state anxiety levels. This study indicated however, that utilizing various locus of instructional control options does not produce undesirable levels of state anxiety that may in return be debilitating toward learning. Therefore, locus of instructional control strategies may not be as important a factor in determining learner state anxiety levels as previously believed.

The research study also indicated that there was a significant relationship between a learner's pretest score and their posttest achievement. This has extremely important implications for CAI designers. By establishing this relationship between prior knowledge and posttest achievement, CAI designers can use pretest scores to identify those learners scoring lower on the pretest and provide them with the extra instructional support they require. Unfortunately the CAI treatments in this study did not perform this function so designers may wish to prepare alternative strategies to accommodate these learners.

Finally, the CAI designer must be aware that the various locus of instructional control strategies require different amounts of instructional time for students to complete the lesson. In this study, the learner control with advisement treatment required significantly more time to compete the lesson than did the learner control condition yet showed no significant achievement gain. By providing learners with control options and with advisement it may have caused learners to not trust their own judgement as to the instructional support they needed. Students in the learner control with advisement group not only spent more time on task but also attempted more embedded questions than did the learner control without advisement group.

Recommendations

The results of this empirical study support the need for more extensive investigation concerning the design of interactive CAI courseware. The following recommendations are made for additional study in this area:

1. Further investigation of the types of advisement and occasions (what decision points in the lesson) when advisement is provided to learners during instruction when they are given learner control options.
2. Research exploring the effects of CAI locus of instructional control strategies on learning and other learner attributes such as individuals who exhibit high or low levels of trait anxiety.
3. Closer study and tracking of student learning strategies (e.g. use of sequence flexibility and review opportunities) during the CAI lessons to ascertain learning styles of students with high or low state anxiety levels.
4. Examination of student responding patterns to determine what factors related to the instructional content caused students to attempt questions and what role does advisement have in their decision.
5. The same research could be replicated using younger subjects due to the need for additional information about design of computer courseware for use in the primary and secondary grades.

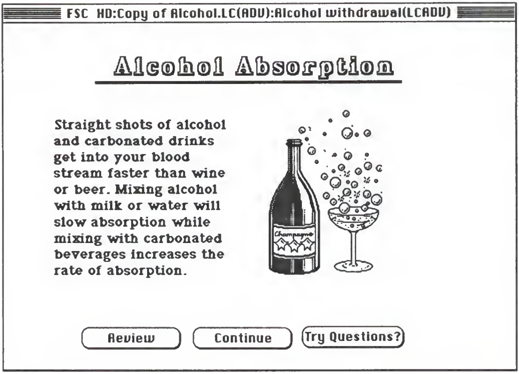
Summary

The research regarding computers in education has suggested that achievement gains attributed to the computer mode of delivery are most likely due to instructional design methodologies incorporated into the CAI courseware. A benefit of CAI cited by many theorists is the capability of providing instructional control to individual learners over lesson pace, sequence, depth of study, questions, and feedback (Hannafin, 1984). By providing this control, it was hypothesized that it would result in greater individualization of instruction, greater achievement, and more positive attitudes toward instruction. However, the current literature has not supported this hypothesis entirely (Steinberg, 1977; Merrill, 1980; Milheim & Azbell, 1988).

Due to the complexity of the interaction between learners and the computer, a number of researchers have suggested a need to examine the interaction of learner attributes with CAI design methodologies (Snow, 1980). Many learner attributes have been implicated as playing a positive or negative role in learning via CAI. Anxiety, due to its potential debilitating effects on learning, may require special consideration by CAI courseware designers. Instructional technologies such as the computer may produce excessive state anxiety reactions that greatly interfere with student cognitive processing. Therefore, elements in CAI designs that may reduce or circumvent anxiety would have both positive affective and cognitive benefits.

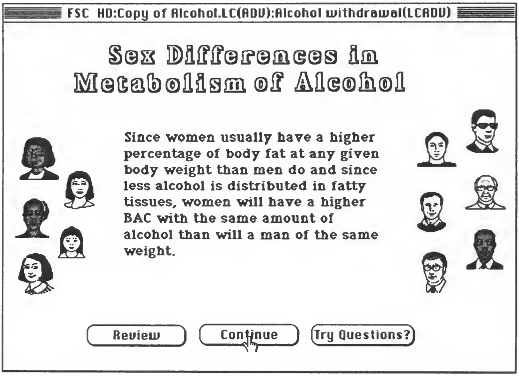
To contribute to the existing body of research, this study was designed to examine the effects of three CAI locus of instructional control strategies on state anxiety levels and learning. The results of this study indicated that the program control, learner control and learner control with advisement CAI locus of instructional control strategies did not result in greater achievement for any one design strategy. The time required for the learner control with advisement group was significantly greater than for the learner control group, but there was no associated achievement gain. For state anxiety levels, while state anxiety did decrease for study subjects as the lesson progressed, there was no difference in anxiety levels associated with locus of instructional control strategy utilized. Also, there was no interaction between on-task anxiety levels and CAI locus of instructional control treatments. The study did indicate that pretests scores were a reliable predictor of posttest achievement from the CAI learning task, while there was no relationship between gender and the interaction of pretest scores by CAI locus of instructional control treatments to posttest achievement.

APPENDIX A
SAMPLE INSTRUCTIONAL FRAMES



Alcohol Absorption

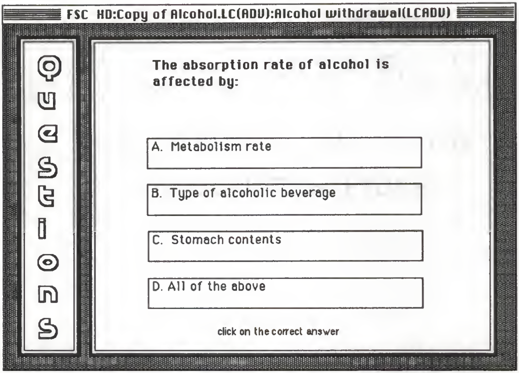
Straight shots of alcohol and carbonated drinks get into your blood stream faster than wine or beer. Mixing alcohol with milk or water will slow absorption while mixing with carbonated beverages increases the rate of absorption.



Sex Differences in Metabolism of Alcohol

Since women usually have a higher percentage of body fat at any given body weight than men do and since less alcohol is distributed in fatty tissues, women will have a higher BAC with the same amount of alcohol than will a man of the same weight.

APPENDIX B
SAMPLE QUESTION FRAMES



The absorption rate of alcohol is affected by:

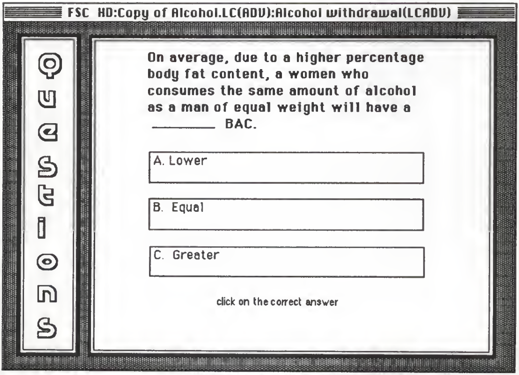
A. Metabolism rate

B. Type of alcoholic beverage

C. Stomach contents

D. All of the above

click on the correct answer



On average, due to a higher percentage body fat content, a women who consumes the same amount of alcohol as a man of equal weight will have a ________ BAC.

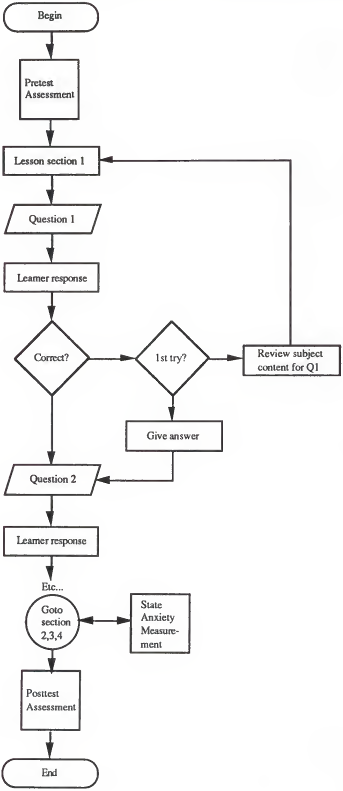
A. Lower

B. Equal

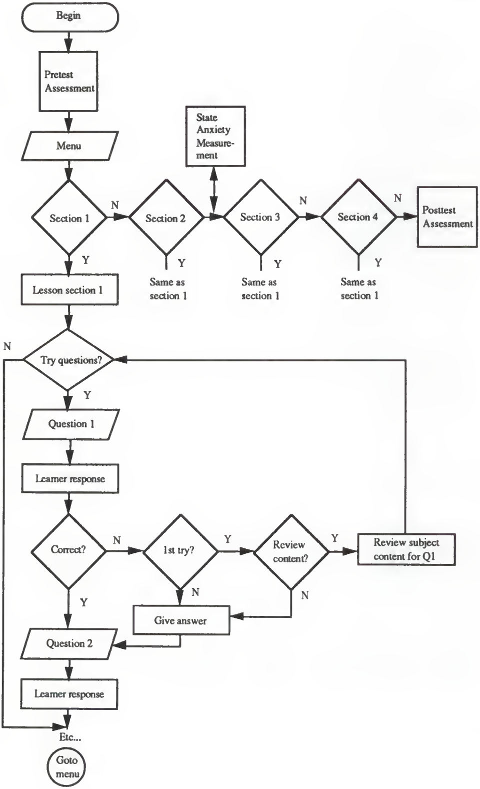
C. Greater

click on the correct answer

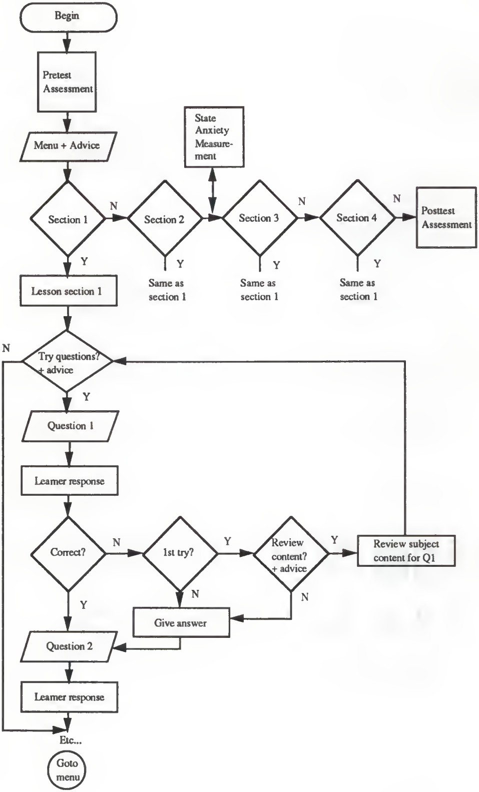
APPENDIX C
SYSTEM-LEVEL FLOWCHART FOR PROGRAM CONTROL



SYSTEM-LEVEL FLOWCHART FOR LEARNER CONTROL



SYSTEM-LEVEL FLOWCHART FOR LEARNER CONTROL WITH ADVISEMENT



REFERENCES

AECT Task Force on Definition and Terminology. (1977). *Educational technology: Definition and glossary of terms.* Washington D.C.: Association for Educational Communications and Technology.

Alessi, S.M., & Trollip, S.R. (1985). *Computer-based instruction: Methods and development.* Englewood Cliffs, NJ: Prentice-Hall.

Balson, P.M., Manning, D.T., Ebner, D.G., & Brooks, F.R. (1984/85). Instructor-controlled versus student-controlled training in a videodisc-based paramedical program, *Journal of Educational Technology Systems, 13*(2), 123-130.

Belland, J.C., Taylor, W.D., Canelos, J., Dwyer, F., & Baker, P. (1985). Is the self-paced instructional program, via microcomputer-based instruction, the most effective method of addressing individual learning differences? *Educational Communications and Technology Journal, 33*(3), 185-198.

Cambre, M.A., & Cook, D.L. (1985). Computer anxiety: Definition, measurement, and correlates. *Journal of Educational Computing Research, 1*(1), 37-54.

Campanizzi, J.A. (1978). Effects of locus of control and provision of overviews in a computer-assisted instruction sequence. *AEDS Journal, 12*(1), 21-30.

Carrier, C.A. (1984). Do learners make good choices? *Instructional Innovator, 29*(2), 15-17.

Carrier, C., Davidson, G., & Williams, M. (1985). The selection of instructional options in a computer-based coordinate concept lesson. *Educational Communication & Technology Journal, 33*(3), 199-212.

Chambers, J.A., & Sprecher, J.W. (1984). Computer-assisted instruction: Current trends and critical issues. In D.F. Walker, & R.D. Hess, (Eds.) *Instructional software: Principles and perspectives for design and use.* Belmont, CA: Wadsworth, Inc.

Clark, R.E. (1983). Reconsidering research on learning from media. *Review of Educational Research, 53*, 445-460.

Clark, R.E. (1984). Research on student thought processes during computer based instruction. *Journal of Instructional Development, 7*(3), 2-5.

Clark, R.E. (1985). Evidence for confounding in computer-based instruction studies: Analyzing the meta-analyses. *Educational Communication and Technology Journal, 33*(4), 249-262.

Collier, R., Poyner, L., O'Neil, H.F., Jr., & Judd, W.A. (1973, February). *Effects of learner control on performance and state anxiety in a computerized learning task.* Paper presented at the annual meeting of the American Educational Research Association, New Orleans.

Cronbach, L.J., & Snow, R.E. (1977). *Aptitudes and instructional methods.* New York: Irvington Press.

Fennema, E.H., & Sherman, J.A. (1977). Sex-related differences in mathematic achievement, spatial visualization, and affective factors. *American Educational Research Journal, 14*, 51-71.

Fernald, P.S., Chiseri, M.J., & Lawson, D.W. (1975). Systematic manipulation of student pacing, the perfection requirement, and contract with a teaching assistant in an introductory psychology course. *Teaching of Psychology, 2*(4), 147-151.

Fisher, M.D., Blackwell, L.R., Garcia, A.B., & Greene, J.C. (1975). Effects of student control and choice on engagement in a CAI arithmetic task in a low-income school. *Journal of Educational Psychology, 67*(6), 776-783.

Freud, S. (1936). *The problem of anxiety.* New York: Psychoanalytic Quarterly Press & Norton.

Fry, J.P. (1972). Interactive relationship between inquisitiveness and student control of instruction. *Journal of Educational Psychology, 63*(5), 459-465.

Futrell, M., & Geisert, P. (1985). A call for action to improve the design of microcomputer courseware. *Educational Technology, 25*(5), 13-15.

Gallagher, P., O'Neil, H.F., Jr., & Dick, W. (1971, February). *Effects of trait state anxiety in a computer-managed instruction course.* Paper presented at a meeting of the American Educational Research Association, New York.

Gay, G. (1986). Interaction of learner control and prior understanding in computer-assisted video instruction. *Journal of Educational Psychology, 78*(3), 225-227.

Goetzfried, L., & Hannafin, M.J. (1985). The effect of the locus of CAI control strategies on the learning of mathematics rules. *American Educational Research Association, 22*, 273-278.

Gray, S.H. (1987). The effect of sequence control on computer assisted learning. *Journal of Computer-Based Instruction, 14*(2), 54-56.

Hannafin, M.J. (1984). Factors affecting the locus of instructional control in the design of computer-assisted instruction. *Journal of Instructional Development, 7*(3), 6-10.

Hannafin, M.J. (1985). Empirical issues in the study of computer-assisted interactive video. *Educational Communication & Technology Journal, 33*(4), 235-247.

Hannafin, M.J., & Colamaio, M.E. (1987). The effects of variations in lesson control and practice on learning from interactive video. *Educational Communication and Technology Journal, 35*, 203-212.

Hansen, J.B. (1972). *An investigation of cognitive abilities, state anxiety, and performance in a CAI task under conditions of no feedback, feedback and learner control.* Austin: University of Texas Computer Assisted Instruction Laboratory. (ERIC Document Reproduction Service No. ED 072 634).

Hedl, J.J., & O'Neil, H.F. (1977). Reduction of state anxiety via instructional design in computer-based learning environments. In J. Sieber, H.F. O'Neil, & S. Tobias (Eds.), *Anxiety, learning, and instruction.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Hull, C.L. (1943). *Principles of behavior.* New York: Appleton.

James, T.G., & O'Neil, H.F. (1971, February). *Effects of sex and stress on state anxiety and performance in computer-assisted learning.* Paper presented at a meeting of the American Educational Research Association, New York.

Johansen, K.J., & Tennyson, R.D. (1983). Effect of adaptive advisement on perception in learner-controlled, computer-based instruction using a rule-learning task. *Educational Communication & Technology Journal, 31*(4), 226-236.

Jonassen, D.H. (1985). Interactive lesson designs: A taxonomy. *Educational Technology, 25*(6), 7-17.

Jonassen, D.H. (1988). *Instructional designs for microcomputer Courseware.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Judd, W.A. (1972). *Learner controlled computer-assisted instruction.* Austin: University of Texas Computer Assisted Instruction Laboratory. (ERIC Document Reproduction Service No. ED 072 635).

Judd, W.A., Bunderson, C.V., & Bessent, E.W. (1970). *An investigation of the effects of learner control in computer-assisted instruction prerequisite mathematics (MATHS).* Computer-Assisted Instruction Laboratory, Technical Report No. 5, The University of Texas at Austin, Austin, TX. (ERIC Document Reproduction Service No. ED 053 532).

Judd, W.A., Daubek, K., & O'Neil, H.F. (1975, March). *Individual differences in learner controlled computer-assisted instruction.* Paper presented at the annual convention of the American Educational Research Association, Washington, D.C.

Kearsley, G., Hunter, B. & Sidel, R.J. (1983). Two decades of computer-based instruction projects: What have we learned? Part two. *Technological Horizons in Education, 10*(4), 88-96.

Kulik, J.A., & Bangert-Drowns, R.L. (1983). Effectiveness of technology in precollege mathematics and science teaching. *Journal of Educational Technology Systems, 12*(2), 137-158.

Kulik, J.A., Bangert, R.L., & Williams, G. (1983). Effects of computer-based teaching on secondary school students. *Journal of Educational Psychology, 75*(1), 19-26.

Kulik, J.A., Kulik, C.C., & Cohen, P.A. (1979). A meta-analysis of outcome studies of Keller's personalized system of instruction. *American Psychologist, 34*(4), 307-318.

Kulik, J.A., Kulik, C.C., & Cohen, P.A. (1980). Effectiveness of computer-based college teaching: A meta-analysis of findings. *Review of Educational Research, 50*, 525-544.

Laurillard, D.M. (1984). Interactive video and the control of learning. *Educational Technology, 24*(6), 7-15.

Leherissey, B.L., O'Neil, H. F., Jr., & Hansen, D.N. (1971). Effects of memory support upon anxiety and performance in computer-assisted learning. *Journal of Educational Psychology, 62*, 413-420.

Levin, H.M. & Meister, G. (1986). Is CAI cost-effective? *Phi Delta Kappan, June* , 745-749.

Louie, S., Luick, A.H., & Louie, J.L. (1985). Locus of control among computer using school children: A report of a pilot study. *Journal of Educational Technology Systems, 14*(2), 101-118.

Mager, R.F. (1961). On the sequencing of instructional content. *Psychological Reports, 9*, 405-413.

Mager, R.F., & Clark, C. (1963). Explorations in student-controlled instruction. *Psychological Reports, 13*, 71-76.

Mayer, R.E. (1976a). Some conditions of meaningful learning for computer programming: Advance organizers and subject control of frame order. *Journal of Educational Psychology, 68*(2), 143-150.

Mayer, R.E. (1976b, April). *Interactive effects of trait anxiety and self-pacing in problem-solving.* Paper presented at the 56th Annual Meeting of the Western Psychological Association, Los Angeles.

Merrill, M.D. (1979, June). *Final report learner-controlled instructional strategies: An empirical investigation.* Working Paper No. 107,.

Merrill, M.D. (1980). Learner control in computer based learning. *Computers and Education,* 4, 77-95.

Milheim, W.D., & Azbell, J.W. (1988). *How past research on learner control can aid in the design of interactive video materials.* In Proceedings of the Annual Meeting of the AECT. (ERIC Document Reproduction Service No. ED 295 652).

Newkirk, R.L. (1973). A comparison of learner control and machine control strategies for computer-assisted instruction, *Programmed Learning and Educational Technology, 10*(2), 82-91.

Oliver, W.P. (1971, February). *Learner and program-controlled sequences of computer-assisted instruction.* Paper presented at Annual Meeting of the American Educational Research Association (ERIC Document Reproduction Service No. ED 046 246).

O'Neil, H.F., Jr., (1972). *Anxiety reduction and computer-assisted learning.* Paper presented at a meeting of the American Psychological Association, Honolulu, Hawaii.

O'Neil, H.F., Jr., Hansen, D.N., & Spielberger, C.D. (1969, February). *Errors and latency of response in computer-assisted learning as a function of anxiety and task difficulty.* Paper presented at a meeting of the American Educational Research Association, Los Angeles.

O'Neil, H.F., Jr., Judd, W.A., & Hedl, J.J., Jr. (1977). State anxiety and performance in computer-based learning environments. In J. Sieber, H.F. O'Neil, & S. Tobias (Eds.), *Anxiety, learning, and instruction.* Hillsdale, NJ: Lawrence Erlbaum Associates.

O'Neil, H.F., Jr., & Richardson, F.C. (1977). Anxiety and learning in computer-based learning environments. In J. Sieber, H.F. O'Neil, & S. Tobias (Eds.), *Anxiety, learning, and instruction.* Hillsdale, NJ: Lawrence Erlbaum Associates.

O'Neil, H.F., Jr., Spielberger, C.D., & Hansen, D.N. (1969). The effects of state anxiety and task difficulty on computer-assisted learning. *Journal of Educational Psychology, 60*, 343-350.

Oosthoek, H., & Ackers, G. (1973). The evaluation of an audio-taped course (II). *British Journal of Educational Technology, 4*, 55-73.

Reigeluth, C.M. (1983). *Instructional-design theories and models: An overview of their current status.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Reiser, R.A. (1980). Interaction between locus of control and three pacing procedures in a personalized system of instruction. *Educational Communication and Technology Journal, 28*, 194-202.

Reiser, R.A., & Sullivan, H.J. (1977). Effects of self-pacing and instructor-pacing in a PSI course. *Journal of Educational Research, 71*(1), 8-12.

Roblyer, M.D. (1981). Instructional design vs. authoring of courseware: Some crucial differences. *AEDS Journal, 14*(4), 173-181.

Roblyer, M.D. (1985). *Measuring the impact of computers in instruction.* Washington, D.C.: The Association for Educational Data Systems.

Roblyer, M.D. (1988). Fundamental problems and principles of designing effective courseware. In D.H Jonassen (Ed.), *Instructional designs for microcomputer courseware.* Hillsdale, NJ: Lawerence Erlbaum Associates.

Rohner, D.J. & Simonson, F.R. (1981, April). *Development of an index of computer anxiety.* Paper presented at the annual convention of the Association of Educational Communication and Technology, Philadelphia, (ERIC Document Reproduction Service No. 207 487).

Ross, S.M. (1984). Matching the lesson to the student: alternative adaptive designs for individualized learning systems. *Journal of Computer-Based Instruction, 11*(2), 42-48.

Ross, S.M., & Rakow, E.A. (1980). Adaptive design strategies for the teacher-managed course. *Journal of Instructional Psychology, 7,* 13-19.

Ross, S.M., & Rakow, E.A. (1981). Learner control versus program control as adaptive strategies for selection of instructional support on math rules. *Journal of Educational Psychology, 73*(5), 745-753.

Santogrossi, D.A., & Roberts, M.C. (1978). Student variables related to rates of pacing in self-paced instruction. *Teaching of Psychology, 5*(1), 30-33.

Seymour, S.L., Sullivan, H.J., Story, N.O., & Mosely, M.L. (1987). Microcomputers and continuing motivation. *Educational Communication & Technology Journal, 35*(1), 18-23.

Sieber, J.E. (1977). Development of the concept of anxiety. In J. Sieber, H.F. O'Neil, & S. Tobias (Eds.), *Anxiety, learning, and instruction.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Sieber, J.E., O'Neil, H.F. Jr., & Tobias, S. (1977). *Anxiety, learning, and instruction.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Snow, R.E. (1980). Aptitude, learner control, and adaptive instruction. *Educational Psychologist, 15*, 151-158.

Spence, K.W. (1956). *Behavior theory and conditioning.* New Haven, Conn: Yale University Press.

Spence, K.W. (1958). A theory of emotionally based drive (D) and its relation to performance in simple learning situations. *American Psychologist, 13*, 131-141.

Spielberger, C.D. (1966). *Anxiety and behavior.* New York: Academic Press.

Spielberger, C.D. (1975). Anxiety: State-trait process. In C.D. Spielberger & I.G. Sarason (Eds.), *Stress and anxiety* (Vol. 1), Washington, D.C.: Hemisphere.

Spielberger, C.D. (1979). *Preliminary manual for the state-trait personality inventory (STPI).* University of South Florida.

Spielberger, C.D. (1983). *Manual for the state-trait anxiety inventory (Form Y).* Palo Alto, CA: Consulting Psychologists Press, Inc.

Spielberger, C.D., Gorsuch, R.L., & Lushene, R.E. (1970). *Manual for the state-trait anxiety inventory.* Palo Alto, CA: Consulting Psychologists Press.

Spielberger, C.D., O'Neil, H.F., & Hansen, D.N. (1972). Anxiety drive theory and computer-assisted learning. In B.A. Maher (Ed.) *Progress in experimental personality research.* New York: Academic Press.

Steinberg, E.R. (1977). Review of student control in computer-assisted instruction. *Journal of Computer-Based Instruction, 3*(3), 84-90.

Taylor, J.A. (1953). A personality scale of manifest anxiety. *Journal of Abnormal and Social Psychology, 48,* 285-290.

Taylor, J.A. (1956). Drive theory and manifest anxiety. *Journal of Abnormal Social Psychology, 53,* 303-320.

Tennyson, R.D. (1975). Adaptive instructional models for concept acquisition. *Educational Technology, 15*(4), 7-15.

Tennyson, R.D. (1980). Instructional control strategies and content structure as design variables in concept acquisition using computer-based instruction. *Journal of Educational Psychology, 72*(4), 525-532

Tennyson, R.D. (1981). Use of adaptive information for advisement in learning concepts and rules using computer-based instruction. *American Educational Research Journal, 18*(4), 425-438.

Tennyson, R.D., & Buttrey, T. (1980). Advisement and management strategies as design variables in computer-assisted instruction. *Educational Communication & Technology Journal, 28,* 169-176.

Tennyson, R.D., Park, O., & Christensen, D.L. (1985). Adaptive control of learning time and content sequence in concept learning using computer-based instruction. *Journal of Educational Psychology, 77*(4), 481-491.

Tennyson, R.D., & Rothen, W. (1979). Management of computer-based instruction: Design of an adaptive control strategy. *Journal of Computer-Based Instruction, 5*(3), 63-71.

Tobias, S. (1979). Anxiety research in educational psychology. *Journal of Educational Psychology, 71*(5), 573-582.

Vargas, J.S. (1986). Instructional Design Flaws in computer-assisted instruction. *Phi Delta Kappan, June*, 738-744.

Wager, W., & Gagne, R.M. (1988). Designing computer-aided instruction. In D.H Jonassen (Ed.), *Instructional designs for microcomputer courseware.* Hillsdale, NJ: Lawerence Erlbaum Associates.

Winn, W. (1980). Why Media? *Instructional Innovator, 29*, 31-32.

BIOGRAPHICAL SKETCH

Randall Phillip Coorough was born on September 18, 1959, to Gary and Ann Coorough in the city of La Crosse, Wisconsin. He graduated from La Crosse's Central High School in 1978. He then attended the University of Wisconsin-La Crosse and obtained a Bachelor of Science in community health education in 1982. Mr. Coorough then attended the University of Florida to pursue a Master of Arts in Health Education. Before graduating with a Master of Arts in Health Education in 1985, Mr. Coorough enrolled as a Ph. D. student in instruction and curriculum at the College of Education of the University of Florida. Mr. Coorough held numerous teaching positions while studying at the University of Florida. He received diverse and extensive teaching experience through graduate teaching assistantships with the Departments of Health Science Education, Division of Housing, Instruction and Curriculum, and the Office of Instructional Resources' Faculty Support Center for Computing. Mr. Coorough also held a faculty position as Assistant in Instruction and Media Resources in the College of Law's Legal Information Center during a one year recess from studying. In December 1989, Mr. Coorough accepted a position as the Director of the Instructional Technology and Support Center, a division of Valencia Community College which is located in Orlando, Florida.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Lee J Mullally
Lee J. Mullally, Chairman
Associate Professor of
Instruction and Curriculum

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

William Chen
William W. Chen
Associate Professor of Health
Science Education

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Jeffry A Hurt
Jeffry A. Hurt
Assistant Professor of
Instruction and Curriculum

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

David Miller
David Miller
Assistant Professor of
Foundations of Education

This dissertation was submitted to the Graduate Faculty of the College of Education and to the Graduate School and was accepted as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

May, 1990

David C Smith

Dean, College of Education

Dean, Graduate School